DECEMBER 1967 TWO SHILLINGS

# tape recorder

TAPE RECORDER DESIGN SURVEY-REPORT

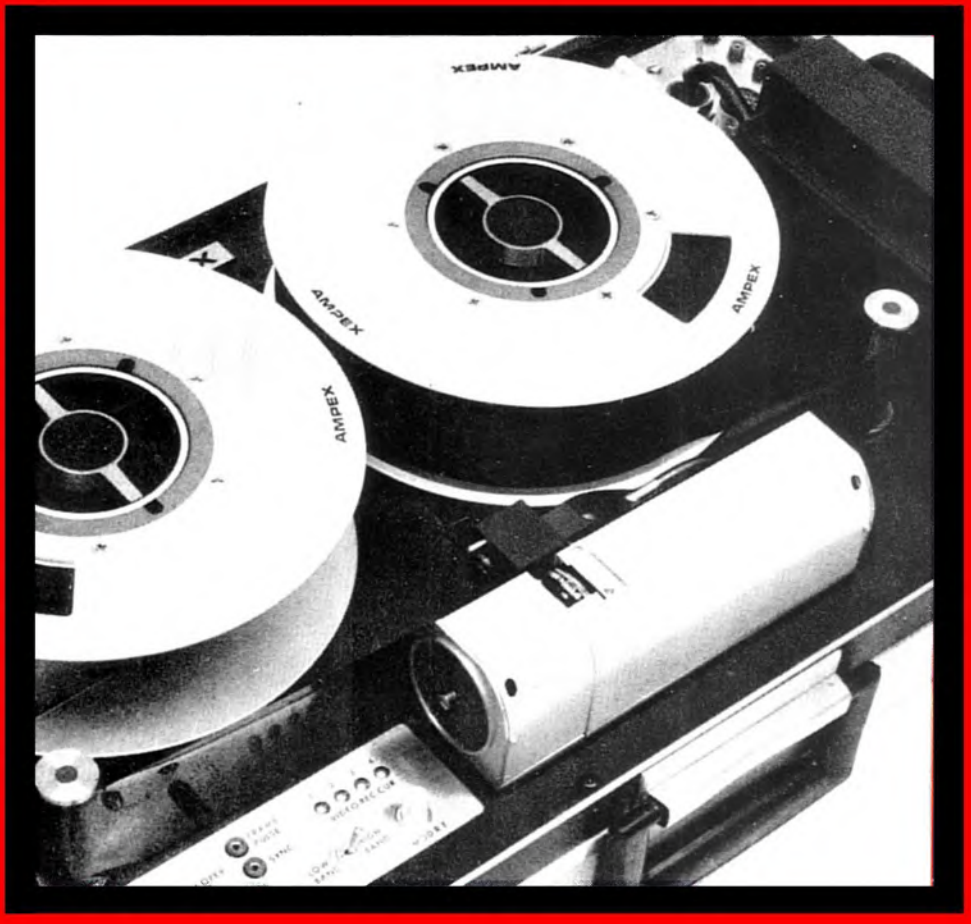
CONSTRUCT A STEREO TRANSISTOR AMPLIFIER

TAPE RECORDER SERVICE -- REPS R.10

A GLANCE AT RADIO BALLADS

BSR TD.20 TAPE DECK REVIEW

TELEVISION RECORDING OUT OF DOORS




# Tandberg Series 9
# the world's finest portable, mono record & playback system

**Features:**
* Available with either a teak finish or in the new 'Aero' carrying case.
* Two or four track.
* Highest quality 'built-in' speakers and amp system.
* Suitable for all Home, Office and Educational use.
* Micro-switch automatically stops spools when tape runs out.
* Remote control facilities if required.

**Specification:**
*Recording System:* 4 or 2 track mono.
*Tape Heads:* 1 erasing head, 1 record/playback head.
*Tape Speeds:* $7\frac{1}{2}$, $3\frac{3}{4}$, $1\frac{7}{8}$ i.p.s.

*Speed Tolerance:* Better than 1.5%.
*Internal Speakers:* 7" x 4" Goodman at 4 ohms impedance.
*Frequency Response:*
$7\frac{1}{2}$ i.p.s. : 30-20,000 c/s ($\pm$ 2 db 40-16,000 c/s)
$3\frac{3}{4}$ i.p.s. : 30-13,000 c/s ($\pm$ 2 db 50-10,000 c/s)
$1\frac{7}{8}$ i.p.s. : 30-7,000 c/s ($\pm$ 2 db 60-5,000 c/s)
*Wow% R.M.S.*
$7\frac{1}{2}$ i.p.s. : better than 0.1%
$3\frac{3}{4}$ i.p.s : better than 0.15%
$1\frac{7}{8}$ i.p.s. : better than 0.25%
*Signal/noise ratio:*
At 5% distortion: 56 db.

Price: From 69 Gns.

THE BEST TAPE RECORDERS BY **Tandberg**

Please send me full details on the Tandberg
**SERIES 9**
Also full details on the Series
6 ☐ 8 ☐ 12 ☐ tick as appropriate

Name .....

Address .....

.....

Post to Dept. TR 13
Elstone Electronics Limited,
Hereford House, North Court,
off Vicar Lane, Leeds, 2.


# Over 200 different Tape Recorders to choose from:

# ONLY ONE IS RIGHT FOR YOU

**RIDICULOUS** to buy your tape recorder without first seeing and hearing the fantastic selection that is available to you. With so many different models on the market, designed for so many different jobs, you risk buying the wrong type unless you first see the full range and discuss your choice with experts. At **THE TAPE RECORDER CENTRE** where we specialise exclusively in tape recorders—you will find the most comprehensive display of tape recorders in Gt. Britain—possibly the world —and the most helpful and expert advice available today.

★ ★ ★

**IMPOSSIBLE** to inspect, other than at **THE TAPE RECORDER CENTRE** all the tape recorders available today. You could spend weeks listening and comparing different models in a dozen different shops. At **THE TAPE RECORDER CENTRE** we've picked the best from Britain, Denmark, Sweden, Japan, Germany and elsewhere ; the latest Akai, Bang & Olufsen, Revox, Sony are all available for immediate demonstration and comparison.

★ ★ ★

**COMMONSENSE** that a visit to **THE TAPE RECORDER CENTRE** is your wisest choice. We have tape recorders from 20 gns. to 500 gns., also a wonderful selection of brand new 1967 models, shopsoiled and secondhand tape recorders showing savings of up to 60 per cent. A visit to **THE TAPE RECORDER CENTRE** can save you a lot of money.

★ ★ ★

Open 9 a.m. to 6 p.m. Monday to Friday. 9 a.m. to 1 p.m. Saturday.
Only one minute from Holborn Underground Station.

**AND INTRODUCING A NEW**
**TAPE RECORDER CENTRE EXCLUSIVE—**

## FREE TRAVEL

Yes, **FREE TRAVEL** to and from **THE TAPE RECORDER CENTRE !** Come up to London, see the sights, purchase your tape recorder from the finest selection in Gt. Britain and have your fares to and from **THE TAPE RECORDER CENTRE** paid in full. Unbelievable ? Then write today for your unique **Free Travel Voucher** to be sent to you by return post. Not a sales gimmick but a genuine offer, for we are certain that once you see the fantastic selection of recorders at **THE TAPE RECORDER CENTRE** you cannot fail to become another of our satisfied customers.

**DO NOT DELAY, SEND TODAY**
**FOR YOUR FREE TRAVEL VOUCHER**

# THE TAPE RECORDER CENTRE

THE TAPE RECORDER CENTRE LTD., 82 HIGH HOLBORN, LONDON, W.C.1. TELEPHONE: CHAncery 7401/8354

# HEATHKIT offer wonderful value in their NEW! Stereo Portable Tape Recorder, STR-1

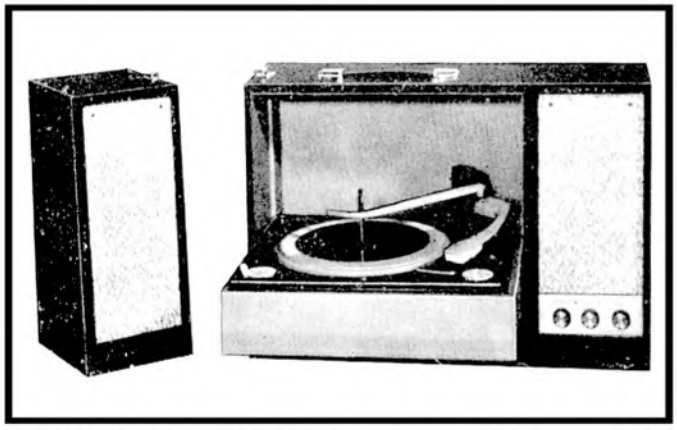
## only £45/18/0 kit

### FOR THIS SPECIFICATION

● ¼ track stereo or mono record and playback at 7½, 3¾ and 1⅞ ips. ● Sound-on-sound and sound-with-sound capabilities. ● Stereo record, stereo playback, mono record on either channel. ● 18 transistor circuit for cool, instant and dependable operation. ● Moving coil record level indicator. ● Digital counter with thumbwheel zero reset. ● Stereo microphone and auxiliary inputs and speaker/headphone outputs . . . front panel mounted for easy access. ● Push-button controls for operational modes. ● Built-in audio power amplifiers giving 4 watts rms per channel. ● Two high efficiency 8" x 5" speakers. ● Operates on 230V AC supply.

**STR-1 SPECIFICATION : Tape Speeds :** 7½, 3¾ and 1⅞ ips. **Wow and Flutter :** Better than 0.15% rms on 7½ ips ; 0.25% rms on 3¾ ips. 0.35% rms on 1⅞" ips. **Tape Size :** ¼" wide, Long or Standard play. **Reel Size :** Standard, up to 7"/5½" spools and tape supplied. **Digital Counter :** 3 digit counter with zero reset. **Heads :** ¼ track erase record and playback. **Microphone :** Moving coil hand microphone (mono) supplied. **Semi-conductor Complement :** 18 transistor, 1 silicon bridge rectifier. **Frequency Response :** 3dB, 40 c/s to 18 kc/s at 7½ ips. 3dB, 40 c/s to 12 kc/s at 3¾ ips. 3dB, 40 c/s to 7½ kc/s at 1⅞ ips. **Signal to noise ratio (unweighted) :** Better than 40dB. **Inputs per channel :** Microphone 0.35mV. Auxiliary 50mV. **Outputs per channel :** 4 watts rms into 15 ohms. 1 volt rms (1,000 ohm source). **Speakers :** Two, high efficiency 8" x 5" pm 15 ohms. **Power requirements :** 200-250V AC, 50 c/s, 60 watts. **Cabinet :** Materials, 9mm. plywood covered with two tone Rexine with chrome fittings. **Dimensions :** 19½" wide x 7⅞" high x 15½" deep.

*Send for full leaflet. Assembled prices on request.*



**SRP-1 SPECIFICATION : Amplifier Frequency Response :** 3dB, 50 c/s to 12 kc/s. **Power Output per channel (rms rating) :** 1.5 watts. **Music power output (total) :** 4.5 watts. **Controls :** Volume, Balance, Tone. **Speakers :** 8" x 5" permanent magnet, 15 ohm. **Transistor and Diode Complement :** 2-BC108 ; 4-AC128 ; 2-AC176 ; 1 silicon diode. **Record Changer : Type :** Model UA 15 SS. **Controls :** Mode : Off, Manual on, Reject, Speed: 16, 33, 45 and 78 rpm. **Record Size :** 12", 10" and 7". **Cartridge :** Stereophonic crystal, LP and 78 turnover sapphire stylus. **General : Power requirements :** 220-250 volts, 50 c/s AC, 30 watts. **Dimensions,** overall, with separate speaker enclosure in place 27" wide x 14¾" high x 7¼" deep.

**SRP-1A** Amplifier Kit **£13/2. SRP-1C** Cabinet and Speakers **£14/13.**

# NEW! Stereo Portable Record Player, SRP-1

## Only £27/15/0 Kit

Assembly can be arranged if required

● Automatic Playing of 16, 33, 45 and 78 rpm records. ● All transistor circuitry ensures cool instant operation. ● Dual sapphire stylus for LP's and 78's. ● Plays mono as well as stereo records. ● Compact, with easy-to-carry handle for suitcase portability. ● Detachable speaker enclosure for best stereo separation. ● Two 8" x 5" speakers. ● Operates on 220-250V AC supply.

**The Heathkit Portable Stereo Record Player** features an all-transistor amplifier for cool, instant operation ; gives a total high-power output of 3 watts rms . . . elegantly styled wooden cabinet with two-tone Rexine covering . . . record changer unit mounted on a swing-down platform ; folds up to make a compact case that's easy to carry from room to room or house to house . . . one speaker enclosure can be detached from the main cabinet to obtain the best stereo separation; clips neatly to cabinet for ease of transportation . . . two high efficiency 8" x 5" speakers for crisp, bold sound . . . changer unit handles up to 6 records of mixed size . . . construction uses a printed circuit board for easy assembly.

Send for the


**Latest Colour Catalogue it's FREE**

The largest selection of Electronic Kit Models in Britain—by Heathkit

**Deferred Terms available on orders over £10 (UK only) Free Delivery U.K.**

**To DAYSTROM LTD., Dept. HT-12, Gloucester. Tel. Glos. 20217**

Please send me **FREE CATALOGUE** (Yes/No) .....

Please send me model(s).....

.....

**NAME** .....
(Block Capitals)
**ADDRESS**.....

.....

**To DAYSTROM LTD., Dept. HT-12, Gloucester.**

Please send FREE copy of Catalogue to my friend.

NAME .....

ADDRESS .....

.....

**VISIT THE HEATHKIT CENTRES**

**LONDON, 233 Tottenham Court Road. Mon.-Fri. 9 a.m.-5.30 p.m. (Sat. 9 a.m.-1 p.m.)**
**BIRMINGHAM, 17-18 St. Martins House, Bull Ring. Tue.-Sat. 9 a.m.-6 p.m. (Thur. 8 p.m.)**

# SONY research makes the difference

**TC260 Features:** 4 track, 2 channel, stereophonic and monophonic tape recording and playback system ☐ Reliable SONY solid state circuit ☐ Smooth and wide frequency response ☐ Public address facilities ☐ Separate bass and treble tone controls ☐ Horizontal or vertical operating position ☐ Two tape speeds (7½ and 3¾ ips) ☐ Full 7″ reel capacity ☐ Automatic shut-off switch ☐ Tape index counter, two VU meters ☐ Automatic tape lifter ☐ Pause control ☐ Voltage selector ☐ Integrated input and output connectors.

**Specifications:**
**Power requirement:** 55 W, 110/125 V, 220/240 V, 50/60 cps.
**Tape speed:** 7½″ and 3¾″ per sec.
**Reel size:** 7″ or smaller.
**Recording system:** 4-track stereophonic and monophonic.
**Frequency response:** 30–18,000 cps at 7½ ips. (50–15,000 cps at 7½ ips ± 3db). 30–13,000 cps at 3¾ ips.
**Signal-to-noise ratio:** Better than 50 db (at peak recording level).
**Wow and flutter:** Less than 0.19% at 7½ ips. Less than 0.25% at 3¾ ips.
**Erase head:** In-line (stacked) quarter track, EF18–2902H.
**Record/Playback head:** In-line (stacked) quarter track PP30–4202.
**Level indication:** Two VU meters (calibrated to 0 VU at 12 db below saturation of tape).
**Tone control:** Two separate controls for bass and treble.
**Input:** Low impedance microphone inputs —transistorised (will accommodate any microphone from 250 ohm to 1 K ohm impedance). Sensitivity—68 db (0.3 mv) (2). High impedance auxiliary inputs. Sensitivity —16 db (0.12 v) (2).
**Output:** Low impedance line outputs (2). Output level 0 db (0.775 v). External Speaker jacks (8 ohms) (2). Integrated Record/Playback. Connector (1). Binaural monitor output (1). Output level 0 db (0.775 v)
**Operating position:** Either horizontal or vertical.
**Speaker:** 4″ x 8″ dynamic (2).
**Power output:** 5 watts x 2.
**Transistors:** 2SB381 (x6), 2SB382 (x2), 2SB383 (x2), 2SC297 (x1), 2SC298 (x4), 2SD64 (x6).
**Weight:** Approx. 34 lbs. 3 ozs.
**Dimensions:** 21 5/16″ (W) x 15 7/16″ (D) x 7⅞″ (H).
**Accessories:** 5″ stereo recorded tape. Empty 7″ reel. Microphone Model F-96 (2). Connection cord. Capstan. Pinch roller. Reel cap. Head cleaning ribbon.

Recommended retail price **97 Gns.**

Sony offer the finest range of tape recorders from the battery portable TC 900 to the studio quality 777.
For further details see your Sony dealer or write to:
**Sony U.K. Sales Division,**
Eastbrook Road, Gloucester.

London Showrooms:
70-71 Welbeck Street, London, W.1.
Tel: HUNter 2143

**SONY®**
**RESEARCH MAKES THE DIFFERENCE**

IMMEDIATE DELIVERY!

# K. J. ENTERPRISES

EVERYTHING AUDIO!

**BRITAIN'S PREMIER MAIL-ORDER RECORDING TAPE SPECIALISTS**

**IMMEDIATE 24 HOUR SERVICE ON ADVERTISED LINES**

FULL CASH REFUND GUARANTEED — SEND TODAY AND SAVE!

# BRANDED TAPES OFFER!

**Brand New, Fully Guaranteed, and in normal manufacturer's pack**

## 25% OFF AGFA & KODAK

| LONG PLAY | APPROX. LIST PRICE | OUR PRICE |
|---|---|---|
| 3" 210' Agfa only | 8/- | 6/- |
| 3¼" 300' Kodak only | 11/- | 8/3 |
| 4" 450' Agfa only | 14/- | 10/6 |
| 4¼" 600' Agfa Only | 22/6 | 17/- |
| 5" 900' ... ... | 28/- | 21/- |
| 5¾" 1,200' ... ... | 35/- | 26/3 |
| 7" 1,800' ... ... | 50/- | 37/6 |

| DOUBLE PLAY | APPROX. LIST PRICE | OUR PRICE |
|---|---|---|
| 3" 300' Agfa only | 13/- | 9/9 |
| 3¼" 400' Kodak only | 17/- | 12/9 |
| 4" 600' Agfa only | 24/- | 18/- |
| 4¼" 900' Agfa only | 35/6 | 26/8 |
| 5" 1,200' ... ... | 42/- | 31/6 |
| 5¾" 1,650' Kodak only | 52/6 | 39/6 |
| 5¾" 1,800' Agfa only | 56/6 | 42/6 |
| 7" 2,400' ... ... | 77/6 | 58/3 |

| TRIPLE PLAY | APPROX. LIST PRICE | OUR PRICE |
|---|---|---|
| 3" 450' ... ... | 21/6 | 16/3 |
| 3¼" 600' Kodak only | 27/6 | 20/9 |
| 4" 900' ... ... | 38/6 | 29/- |
| 4¼" 1,200' Agfa only | 47/6 | 35/9 |
| 5" 1,800' ... ... | 65/6 | 49/3 |
| 5¾" 2,400' ... ... | 90/- | 67/6 |
| 7" 3,600' ... ... | 115/- | 86/3 |

| STANDARD PLAY | APPROX. LIST PRICE | OUR PRICE |
|---|---|---|
| 5" 600' } Kodak only | 18/- | 13/6 |
| 5¾" 900' } Kodak only | 24/6 | 18/6 |
| 7" 1,200' } Kodak only | 30/6 | 22/6 |
| *QUADRUPLE PLAY* | | |
| 3" 600' } Kodak only | 33/6 | 25/3 |
| 3¼" 800' } Kodak only | 42/- | 31/6 |
| 4" 1,200' } Kodak only | 58/6 | 44/- |

Postage and Packing 2/-. ORDERS OVER £3 POST FREE.

## 20% OFF — BASF — E.M.I. — GRUNDIG — PHILIPS — SCOTCH

### PHILIPS — BASF — E.M.I.

| | LIST PRICE | OUR PRICE |
|---|---|---|
| *STANDARD PLAY* | | |
| 4" 300' PHILIPS | 10/6 | 8/6 |
| 5" 600' | 21/- | 16/10 |
| 5¾" 900' | 28/- | 22/6 |
| 7" 1,200' | 35/- | 28/- |
| *LONG PLAY* | | |
| 3" 210' | 9/- | 7/3 |
| 4" 450' | 14/6 | 11/8 |
| 4¼" 600' BASF | 21/- | 16/10 |
| *5" 900' | 28/- | 22/6 |
| *5¾" 1,200' | 35/- | 28/- |
| *7" 1,800' | 50/- | 40/- |
| 8¼" 2,400' } BASF | 72/6 | 58/- |
| 10" 3,600' } Only | 95/- | 76/- |
| C.60 Cassette | 17/6 | 14/- |
| C.90 Cassette | 25/- | 20/- |

| | LIST PRICE | OUR PRICE |
|---|---|---|
| *DOUBLE PLAY* | | |
| 3" 300' | 14/- | 11/3 |
| 4" 600' | 25/- | 20/- |
| 4¼" 900' BASF | 30/- | 24/- |
| 5" 1,200' | 42/- | 33/8 |
| *5¾" 1,800' | 55/6 | 44/6 |
| *7" 2,400' | 77/6 | 62/- |
| *TRIPLE PLAY* | | |
| 3" 450' | 22/- | 17/8 |
| 4" 900' | 39/- | 31/3 |
| *4¼" 1,200' BASF | 49/- | 39/3 |
| 5" 1,800' | 66/- | 52/10 |
| 5¾" 2,400' } BASF | 90/- | 72/- |
| 7" 3,600' } Only | 115/- | 92/- |

**GRUNDIG TAPE AVAILABLE ONLY WHERE MARKED WITH ASTERISK**

### SCOTCH

| | LIST PRICE | OUR PRICE |
|---|---|---|
| *STANDARD PLAY* | | |
| 5" 600' | 20/6 | 16/4 |
| 5¾" 850' | 27/6 | 22/- |
| 7" 1,200' | 35/- | 28/- |
| *LONG PLAY* | | |
| 3" 300' | 9/6 | 7/6 |
| 4" 450' | 14/6 | 11/8 |
| 5" 900' | 27/6 | 22/- |
| 5¾" 1,200' | 34/6 | 27/6 |
| 7" 1,800' | 49/- | 39/- |
| 8½" 2,400' | 72/6 | 58/- |
| *STANDARD (ACETATE)* | | |
| 5¾" 850' | 24/6 | 19/6 |
| 7" 1,200' | 30/- | 24/- |

| | LIST PRICE | OUR PRICE |
|---|---|---|
| *DOUBLE PLAY* | | |
| 3" 400' | 16/6 | 13/2 |
| 4" 600' | 24/6 | 19/6 |
| 5" 1,200' | 41/9 | 33/6 |
| 5¾" 1,800' | 55/- | 44/- |
| 7" 2,400' | 76/6 | 61/- |
| *TRIPLE PLAY* | | |
| 3" 600' | 24/9 | 19/6 |
| 4" 900' | 38/6 | 30/6 |
| *DYNARANGE (L/P)* | | |
| 5" 900' | 32/3 | 25/10 |
| 5¾" 1,200' | 40/6 | 32/6 |
| 7" 1,800' | 57/6 | 46/- |
| 8¼" 2,400' | 83/6 | 66/10 |

Postage and Packing 2/-. ORDERS OVER £3 POST FREE.

## PHONOBAND—Pre-recorded STEREO tapes from Sweden

Brilliantly recorded, ¼-track stereo tapes superb quality Classical Jazz and Light Music at Tape speeds of 7½ i.p.s. (7" reels) and 3¾ i.p.s. (5" reels). **PRICES FROM 49/6.**

**Send for our Full Colour Catalogue and Price List.**

## TRIPLE PLAY TAPE — 50% OFF!

A large purchase from TWO world renowned manufacturers enables us to make this unique half-price offer. Brand new, fully guaranteed, premium grade Polyester Base Tape with FULL LEADER and stop foil. In original maker's box and Polythene wrapped at these EXCEPTIONALLY LOW PRICES !

| | LIST PRICE | ONE | THREE | SIX |
|---|---|---|---|---|
| 1,800' on 5" reel GEVASONOR | 66/- | 34/- | 101/- | 198/- |
| Also available at substantial reductions. | | | | |
| 450' on 3" reel GEVASONOR | 22/- | 14/- | 40/6 | 78/- |
| 600' on 3" reel GEVASONOR | 27/6 | 17/6 | 51/- | 99/- |
| 900' on 4" reel GEVASONOR | 39/- | 24/6 | 72/- | 140/- |
| 2,400' on 5¾" reel ZONAL | 90/- | 55/6 | 165/- | 324/- |

Post and Packing 2/-. ORDERS OVER £3 POST FREE.

## ILFORD TAPE NEAR HALF PRICE

A bulk purchase of premium grade, top quality POLYESTER MAGNETIC TAPE from one of the world's foremost experts in film coating technology. With FULL LEADER, stop foil. Polythene wrapping, and in original manufacturer's boxes. Available in long-play base only at these BARGAIN PRICES.

| | | ONE | THREE | SIX |
|---|---|---|---|---|
| 900' on 5" reel. | List price 28/- | 16/6 | 48/- | 90/- |
| 1,800' on 7" reel. | List price 50/- | 32/6 | 95/- | 180/- |

Post and Packing 2/-. ORDERS OVER £3 POST FREE.

## SCOTCH TAPE—HALF PRICE!

Brand new, top quality premium grade, POLYESTER BASE TAPE, double coated and made specially for the electronics industry.

SCOTCH (150 D/C) Polyester L/P, 900" on 7" reel. **ONLY 15/6,** P. & P. 2/-. Three reels for **45/-** post free; six reels for **84/-,** post free. Boxed, add 1/- per reel. Can be supplied on 5¾" reels at special request.

**Don't forget our other ACCESSORY BARGAINS !**

**Tape Head Demagnetiser,** essential for any enthusiast ! Ready for immediate use. Fully guaranteed. Worth 50/- ... ... ... ... **Only 27/6** P. & P. 2/-

**Tape Splicer,** fully auto., no razor blades. Worth 32/6 ... **Only 16/6** P. & P. 2/-

**International Polyester Tape,** 2,400' 7" reel (boxed) ... **Only 25/-** P. & P. 2/-

**Gevasonor** 10" 3,600' L/P Polyester (boxed) ... ... **Only 64/-** Post Free

**Gevasonor** 8¼" 2,400' L/P Polyester (boxed) ... ... **Only 48/6** P. & P. 2/-

**Gevasonor** 3" 300' L/P Polyester (boxed) ... ... ... **6 for 37/6** P. & P. 2/-

**20% OFF ALL GRUNDIG & PHILIPS EQUIPMENT**

SEND FOR LISTS OF OTHER TAPE AND HI-FI BARGAINS

**K. J. ENTERPRISES, (Dept. TR), 17 THE BRIDGE, WEALDSTONE, MIDDLESEX** (OPPOSITE HARROW & WEALDSTONE STATION)

**01-427 0395** (CLOSED P.M. SAT.) — REFUND GUARANTEE

**FREE** Our New illustrated catalogue sent entirely free on request. Britain's most specialized comprehensive range of recording tape and accessories. 20,000 reels always in stock with reductions ranging up to 50%.

# MORE FANTASTIC BARGAINS FROM K.J. ENTERPRISES

WE SAVE YOU MONEY!

## AMPEX TAPE—25% OFF

Brand new, fully guaranteed and in normal manufacturer's pack.

**"500" SERIES AUDIO TAPE (MYLAR BASE)**

| TYPE | DESCRIPTION | LIST PRICE | ONE | OUR PRICE THREE | SIX |
|---|---|---|---|---|---|
| 541-9 | 900' L/P 5" reel | 26/6 | 19/- | 55/- | 105/- |
| 541-12 | 1150' L/P 5½" reel | 33/6 | 25/6 | 74/- | 144/- |
| 541-18 | 1800' L/P 7" reel | 45/- | 29/6 | 86/- | 166/- |
| 551-12 | 1200' D/P 5" reel | 42/- | 31/6 | 92/- | 180/- |
| 551-16 | 1650' D/P 5½"reel | 56/- | 39/6 | 116/- | 226/- |
| 551-24 | 2400' D/P 7" reel | 72/6 | 49/6 | 145 | 284/- |
| | **"600" SERIES PROFESSIONAL AUDIO TAPE (MYLAR BASE)** | | | | |
| 641-9 | 900' L/P 5" reel | 30/6 | 23/- | 66/6 | 127/6 |
| 641-18 | 1800' L/P 7" reel | 52/6 | 39/6 | 116/- | 226/- |
| 651-12 | 1200' D/P 5" reel | 46/- | 34/6 | 101/- | 197/- |
| 651-24 | 2400' D/P 7" reel | 80/- | 60/- | 177/- | 348/- |

Post and Packing 2/-. ORDERS OVER £3 POST FREE.

*N.B.* other types and sizes available including the inexpensive "White Box" series.

## SPECIAL OFFER COMPACT CASSETTES

"MC 60"

Compact cassettes with 60 mins. playing time. Brand New and packed in normal plastic Library Box—available at this exceptional price.

Normally 17/6 **OUR PRICE 21/-**

3 for 35/-
6 for 67/6
12 for 130/-

*Standard Pattern to fit Philips, Stella, Elizabethan, Dansette, Sanyo, etc.*

Post and packing 2/-. Orders over £3 post free.

## BASF TAPE—30% REDUCTION

A Special Offer of this famous Premium Grade Tape. Brand new, boxed with full leader, stop foil and "Polythene sealed". Multiples of three 4" D/P 600' size can be supplied in the BASF 3 compartment plastic library cassettes at no extra cost.

| TYPE | DESCRIPTION | LIST PRICE | ONE | THREE | SIX |
|---|---|---|---|---|---|
| LGS26 | 600' D/P 4" reel | 25/- | 17/- | 49/- | 93/- |
| LGS26 | 1,200' D/P 5" reel | 42/- | 29/6 | 86/- | 166/- |
| LGS26 | 1,800' D/P 5½" reel | 55/- | 38/6 | 112/6 | 219/- |
| LGS26 | 2,400' D/P 7" reel | 77/6 | 49/6 | 145/6 | 285/- |
| PES18 | 900' T/P 4" reel | 39/- | 27/6 | 80/- | 154/- |
| PES18 | 1200' T/P 4½" reel | 49/- | 34/6 | 101/- | 196/- |
| PES18 | 1800' T/P 5" reel | 66/- | 47/6 | 139/6 | 273/- |
| PES18 | 2400' T/P 5½" reel | 90/- | 63/- | 186/- | 365/- |

Post and Packing 2/-. ORDERS OVER £3 POST FREE.

## AGFA TAPE—HALF PRICE!

Brand New, Premium Grade, Polyester Base Tape from this famous manufacturer. Boxed with full leader, stop foil and polythene sealed at this exceptionally attractive price.

| TYPE | DESCRIPTION | LIST PRICE | ONE | THREE | SIX |
|---|---|---|---|---|---|
| PE21 | 1,200' S/P 7" reel | 35/- | 19/6 | 55/6 | 105/- |
| | Also available at substantial reductions. | | | | |
| PE31 | 1,200' L/P 5½" reel | 35/- | 24/6 | 71/- | 137/- |

Post and Packing 2/-. ORDERS OVER £3 POST FREE.

To: K. J. ENTERPRISES (Dept. TR), 17 THE BRIDGE, WEALDSTONE, MIDDLESEX
*Please supply your lists and goods as detailed below :*

| Quantity | Description of Goods | Amount |
|---|---|---|
| | | |
| | Total for post and packing | |

I enclose my remittance for Total £.....

NAME.....

ADDRESS .....

(Print Please).....

December, 1967

# TELEFUNKEN

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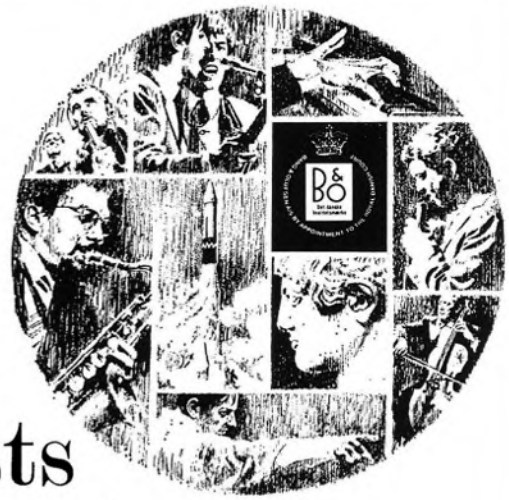

# This year only 465* music enthusiasts will have their greatest wish fulfilled–the perfect High Fidelity system. The most thrilling system ever– and made by Bang and Olufsen.

**1** **BEOLAB 5000.** 2 x 60 watts R.M.S. silicon transistor amplifier. Power available to reproduce full original volume at all frequencies in association with loudspeakers of normal efficiency (1–2%). Cursor type controls in place of knobs for slide-rule accuracy in setting. Comprehensive variable inputs and duplicated phono & Din outputs. Elegant long low free-standing cabinet in solid Teak or Rosewood. 120 gns.

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**3** **BEOVOX 3000.** Pressure chamber loudspeaker with separate bass, mid and high (x 2) frequency units. Variable attenuators to the mid and high frequency units. Provision for the connection of a separate high frequency diffuser unit (Beovox 2500). Maximum power handling capacity 50 watts music power, impedance 4 ohms. Solid Teak or Rosewood finish. 45 gns.

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# Bang & Olufsen Beolab Series

*Only a limited number of Systems are being produced this year—so see and hear Beolab soon at your B & O dealer or write for detailed information to

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# tape recorder

DECEMBER 1967 VOLUME 9 NUMBER 12

INCORPORATING
SOUND AND CINE

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**COVER PICTURE**

A studio-quality battery portable video tape recorder is the latest rabbit to emerge from the *Ampex* hat. Even at £23,000 this television studio in miniature retains Ampex in their position as pioneers in the field of high-definition video recording.

**SUBSCRIPTION RATES**

Annual subscription rates to *Tape Recorder* and its associated journal *Hi-Fi News* are 30s. and 38s. respectively. Overseas subscriptions are 32s. 6d. (U.S.A. $4.50) for *Tape Recorder* and 38s. (U.S.A. $5.40) for *Hi-Fi News*, from Link House Publications Ltd., Dingwall Avenue, Croydon, CR9 2TA.
*Tape Recorder* is published on the 14th of the preceding month unless that date falls on a Sunday, when it appears on the Saturday.

IT IS DIFFICULT to inject the Yuletide Spirit into a journal that is prepared in mid-October for publication in mid-November. In lieu of festivities, however, we include in this issue a brief script of seasonal relevance, giving our 48% play-makers time to produce a short piece for the enlightenment of visiting relatives and friends. This is the time of year when tape recorder sales are at a peak and, even if amateur drama recordings fail to convey a literary message, they still show the versatility of domestic recorders to uninitiated audiences.

When *Philips* introduced the *EL3300* cassette recorder in 1964 several pundits forecast, as did Prophet of Doom Kenneth Glenwood, that "the battle of cartridge against spool is . . . beginning." It is proving by no means a straight battle for Philips, however. There are now many cassette designs competing—not so much with the spool as with *each other*. Pity the poor motorist, for example. Having purchased a mono or stereo cassette-player for his car, he drives from record-retailer to record-retailer with the baleful plea: "Have you any cassettes to fit *So and so*?" "So and So" may be a Philips player, in which case his request has some chance of a positive answer, or it may be one of many units imported from America and Japan. Even in London, finding a cassette compatible with any one American or Japanese player must be comparable with rescuing a needle from a magnetic haystack.

Cassette systems are by no means a new idea. An *RCA* design, remarkably similar to the Philips, reached the prototype stage long before the latter was conceived but was (in our opinion — wisely) subsequently forgotten. *Loewe Opta* and *Garrard* piloted magazine systems which, had they received the financial backing and competent publicity afforded to Philips products, might still have been with us today. Whatever happened to the *Eumig* system or to the pre-recorded *Grundig* cassettes promised in 1965? Despite its comparative youth, the high fatality rate of cassette systems has rendered the Philips *C.60* very much a Grand Old Man in its field—at the ripe age of three years.

Car-cassette equipment has lately been presented by importers as a revolutionary development in sound recording. Eight-track stereo, endless-loops and slot-loading, far from being in any sense the "latest thing", have been with us since 1963, when they were applied to car players by the Los Angeles *Telescript* company. The majority of American and Japanese units now being marketed resemble Telescript designs closely. The resemblance does not stretch to price, however. Telescript sold their players for about £18, whereas the average price of similar equipment in this country is some £35.

Though the Philips car players are substantially cheaper and more compact than the endless-cassette units, commercially-recorded material for both basic systems is surprisingly expensive. £2 5s. for a 60-minute programme (ninepence per minute) is the general figure around which endless and reel-to-reel cassettes revolve. The background dirge of a car-radio may be pleasant to many drivers, but only the most wealthy, it would seem, may enjoy the background of a single oft-repeated dirge.

Our own experiments in musical driving have centred upon conventional battery recorders, programmed with favourite pieces from tape and disc. Repeated playing under relatively noisy conditions created, in the course of days, an abhorrence of the music, resulting in the former "favourites" being erased or, where on disc, left evermore unplayed. It would be interesting to hear from readers possessing car players how quickly their cassette programmes become tedious. Other readers might care to suggest the contents of a short loop to cure audio-drug addicts by repetitive brainwashing.

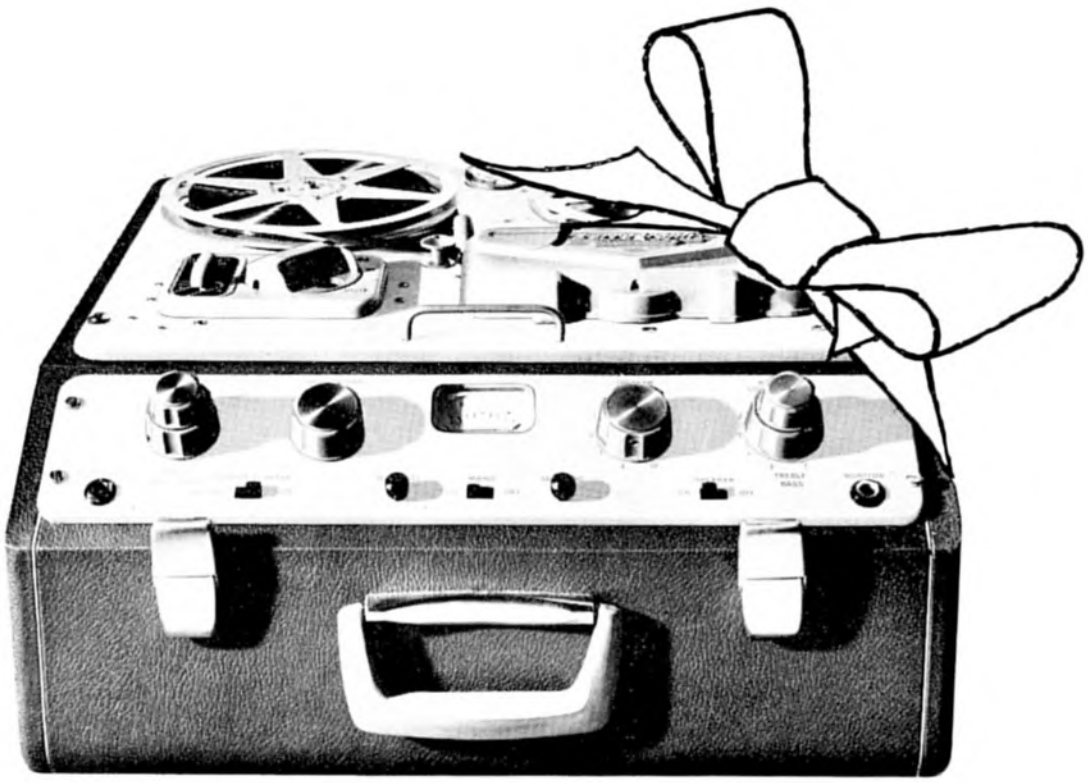
**FEATURE ARTICLES**



**REGULAR ITEMS**



**EQUIPMENT REVIEWS**



# All I want for Christmas is a Ferrograph

You will probably have to be satisfied with a floral tie or a bottle of after-shave but, just in case you are in high favour with a rich uncle or aunt, or your wife's premium bond comes up, or you decide, if needs be, to give yourself a Ferrograph, here are a few details.

The Ferrograph is the tape recorder which, built to an original design has long enjoyed an outstanding reputation for reliability and fidelity of recording. Its high quality of performance is sustained over many years of use, and its construction is of a ruggedness consonant with expectation of long life. Even so, we do not claim perfection, although we believe that we have come nearest to the ideal. And the vast majority of Ferrograph users agree. They include the fire, police and defence services, concert impresarios, theatrical producers, education authorities and many others whose demands are constant and exacting.

There are five models from 95 gns. to 132 gns.

## Something more modest?

If your present won't run to a Ferrograph, or if you are looking for a gift for another enthusiast, how about a Wearite Defluxer? It depolarises all makes of head, prevents hiss and protects tapes from cumulative background noise. 60/- from all good Hi-Fi dealers.

For full details of Ferrograph models and the Wearite Defluxer, write to

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# WORLD OF TAPE

### INTERNATIONAL BROADCASTING CONVENTION

FIVE hundred delegates from some 25 countries attended the *International Broadcasting Convention* in September, held in London at the Royal Lancaster Hotel.

The convention was organised by the Electronic Engineering Association and the Royal Television Society and featured equipment of mainly British manufacture, including the now world-famous *Marconi Mk.3* colour cameras. Pictures of the scenery outside the hotel were produced from a Marconi Outside Broadcast vehicle, while throughout the exhibition a full-scale fashion show and steel band provided lively television material at the company's stand.

*EMI Electronics* featured film clips from *ABC*'s colour series "The Avengers" and used colour television advertisements to link live and telecine sequences. An *Emitape* demonstration, using a modern generation tape for high-band and colour video recording, illustrated another facet of the company's attention to the problems of colour. Other equipment on the EMI stand included the £2,000 Sony professional video recorder and, on the audio side, the BTR4 studio recorder and L4 battery portable.

*Ampex* demonstrated their new *AG-20* battery recorder which was recently used, and depicted on the cover of August *Tape Recorder*, to conduct the first recorded free-fall sky-diving interview. Also shown by Ampex was a new light-weight battery video recorder designed for use on a cameraman's back (see page 522) and the mobile *Video-cruiser*. This is a converted *Chevrolet* providing a complete mobile television unit with luxury surroundings.

### POTENTIAL RIVAL TO THE PHILIPS CASSETTE

NEWS of the first potentially serious rival to the *Philips* cassette system was announced recently by *Clarke & Smith*. In the course of their work for the *Royal National Institute for the Blind* Talking Book Library, they have developed a compact and robust cassette of very high capacity.

The *Tapete* is intended gradually to replace the bulky 6lb. tape recorded books currently being circulated among 22,000 blind subscribers in Britain. Whereas these existing books are too large for a normal letter box, the new cassettes weigh only 6½oz. and are small enough to travel through the letter post. Up to 13 hours recording time is obtainable from each Tapete cassette at a linear speed of $\frac{15}{16}$ i/s, compared with the 60-minute capacity of a standard Philips cassette.

**The World Council for the Blind, representing 80 nations, recently adopted a resolution commending the Clarke & Smith system as the most advanced medium in the world for blind literature. Some 20 countries have requested sample equipments and Clarke & Smith anticipate the Tapete becoming an international standard within three to five years. Patents have been issued in many countries, including the USA where all patent claims have been allowed.**

Clarke & Smith are by no means limiting their new system to RNIB circles. They have ambitious plans to cater for the markets in language tuition, general education, background music, dictation, telephone-answering and, of particular interest, domestic tape recording. Various record/play and play/only units were demonstrated during October in London, all based on a relatively simple tape transport said to be less intricate than a low-price gramophone record changer. Clarke & Smith hope to make these available to the audio industry, even to the extent of including Tapete units in domestic radiograms. This would bring the system into direct competition with that of Philips.

Development of the new cassette has involved expenditure running "well into six figures" but has borne the fruits of some very original thinking. An audio indexing system, for example, simplifies the location of pre-recorded passages. The RNIB have produced textbooks for blind students having two index tracks in addition to six text tracks. The index tracks correspond to the fast-wind speed of the playback mechanism. This index track is dubbed with spoken coding on the lines of "A.8, A.2, A.3" etc. A student may listen to one part of a cassette, pass it to a colleague for further use, and find his position again with the aid of a noted or memorised code. He may have been studying, for example, material on Track 3 at coding K.8. Location of recorded items in this manner is quicker and more convenient than with a gramophone record or conventional tape or disc recording.

New thinking in the realm of language-teaching includes a plan for supplying complete language courses, plus the hardware on which to play them, through a monthly rental scheme. The customer will be able to hire an audio teaching system for use in his home without needing to purchase equipment and tapes which may be of no value to him when his study is completed.

Major J. F. E. Clarke, Chairman of the company, is convinced that open-spool reel-to-reel tape recording will become obsolete within the next few years, despite the disadvantages of closed cassette mediums for the creative amateur and the professional tape recordist.

The Tapete system is intended for $3\frac{3}{4}$, $1\frac{7}{8}$ and $\frac{15}{16}$ i/s speeds.

### AKAI EQUIPMENT STOLEN IN BRADFORD

WE have been asked by *Pullin Photographic* to publish the serial numbers of items stolen from a representative's car recently so that readers and dealers may be aware of their circulation. Two *Akai* tape recorders were taken, an *X-100D* (serial number *87111*) and a model *1710* (serial number *51388*), plus an *AA-7000* tuner/amplifier, a pair of *ASE-9* stereo headphones, an *RM-130* lead and a *D-100* lead. The theft occurred during the night of 16th-17th July in the Bradford area.

### APPEL PROFESSIONAL TAPE EQUIPMENT

PROFESSIONAL cassette tape equipment is now available in Britain, manufactured by the Italian *Appel Electronic Corporation*. The recorders and players are based on an endless-cassette system, tape being removed from the centre of a reel and then taken up at the periphery of the same reel. Claimed wow and flutter of the *Model 311 Continuous Player* is 0.4% p-p at 7½ i/s. Further details are available from : **P. A. G. Accati-Sheard, 20 The Crescent, West Wickham, Kent.**

### SONY BATTERY VTR

DETAILS of the Sony battery video recorder have been trickling into the country during the last few months, followed, now, by the first illustrations. The equipment produces tapes for reproduction on the £350 Sony mains recorder and does not itself have replay facilities. Of particular interest are the miniature CRT view-finder and microphone mounting arrangement ; price in the USA is some £430.

**NEXT MONTH**

**THE FIRST OF several articles describing the Japanese audio industry will appear in our January issue, published on 14th December. The writer of *Made in Japan*, Anthony Eden, has recently returned from the Far East and will describe, in the course of his series, visits to the *Sony* and *Akai* factories. Responding to the interest aroused by his first article, W. H. Myall will continue his analysis of the maths of wow and flutter.**

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View of the TP1002 showing second speaker detached. This fastens to the recorder to provide forward and rear-facing units.

# field trials OF BATTERY PORTABLES

## AIWA TP1002 STEREO MAINS/BATTERY

BY DAVID KIRK

**MANUFACTURER'S SPECIFICATION** Quarter-track stereo mains/battery recorder. **Tape speeds:** 3¾ and 1⅞ i/s (capstan sleeve). **Spool capacity:** 5in. **Record bias:** AC. **Erase Bias:** DC. **Loudspeakers:** two 4 x 2½in. **Output power:** 500mW. **Dimensions:** 3½ x 11 x 15in. **Weight:** 10lb. **Price:** £46 4s. **Distributor: B. Adler and Sons (Radio) Ltd., Coptic Street, London W.C.1.**

"STEREO on a Shoestring" was the caption that accompanied the *New Products* note on the *Aiwa TP1002* in the January issue. The writer of that report might well have been still more cryptic, considering the price asked for this machine. My reaction to a complete stereo tape system at £46 4s. suggests the alternative caption "Stereo on a Spider's Thread".

Since there are no other battery stereo recorders on the market under £100, I found myself unable to compare the TP1002 with machines of similar price. Obviously, the fraction of the price devoted to a second record/play channel, second microphone, second speaker, second earpiece and ¼-track heads reduces that available for the drive mechanism.

### WEAKEST LINK

I do not propose to write at length on the recording quality of this unit. Under domestic living room conditions the sound was poor. The loudspeakers were by far the weakest link in the chain, being particularly bad examples of plastic cabinet mounting. In the less exacting location of a car, however, mono or stereo reproduction of reasonably tolerable quality were obtainable. In the latter case, the ears' 'rejection mechanism' appears to reduce both engine noise and distortion simultaneously.

In return for one's £46 4s. one receives a two-speed ¼-track stereo recorder fitted with a single level-meter switchable from one channel to another. There are no track selectors—a rather absurd example of the 'pairing' necessary to reach the seemingly low price—so the TP1002 may not be used as a conventional ¼-track mono machine without individual modification.

Supplied with the machine is an accessory case containing two moving-coil microphones: one with a single miniature jack plug and the other with a remote-control switch and double jack plug. These are typical of the general run of microphones supplied with domestic recorders of all prices—adequate but well worth replacing with a good *Lustraphone*, *Grampian* or *Sennheiser* dynamic, depending on available funds. It is hardly worth buying, for example, two £10 *DP.4* microphones for the Aiwa, but if comparable microphones are already owned for use with other machines, a suitable plug adaptor would be worth preparing. Miniature jack plugs cannot be soldered or screwed directly to the thick cable supplied by the well-established microphone manufacturers. Even if the contortion is achieved, the weight applied by the cable will almost certainly pull the plug from its socket or, at worst, damage the internal socket contacts. Finally, the accessory case contains two ear-pieces permitting that very enjoyable activity—headphone stereo listening.

The basic recorder, with or without the attachable external speaker, is visually very attractive indeed. It has a substantial handle mounted on metal hinges and incorporates a sensible control layout. 'Left' and 'right' input/output jacks are positioned on the far left and far right of the front panel respectively, gain controls being similarly arranged about the meter, meter-switch and three-position tone control. The latter governs treble response on both channels but was kept permanently at the minimum treble point, in my hands, to suppress motor crackle as much as possible.

### HIGHER LEVEL

This crackle was particularly annoying in that it was present at a much higher level on one channel than on the other. Since the affected track was the upper one, pre-recorded ½-track mono tapes sounded unsatisfactory.

Four press-tab mode selectors are located to the right of the panel. These comprise, from left to right, RECORD, LEFT-WIND, RIGHT-WIND and PLAY: first and the last of the four interlock in the conventional manner. A STOP bar runs the length of the four tabs; this descended so far into the depths of the cabinet, when operated, that it added a rather amateurish touch to an otherwise competent control layout.

### RETURNING BITS

Rather more than a year ago I carried a battery recorder through the bowels of London Bridge Underground Station. Upon reaching the lift, I found three commuters at my tail returning bits that had fallen from the recorder during my brush through the rush-hour crowds. Some minutes prior to this the plastic lid had clattered on to a crowded stairway, barely surviving the stampede of London feet. As an insurance when taking this new Aiwa home, therefore, I Sellotaped the lid firmly to the cabinet. Subsequent experience showed this to be a wise precaution: the lid on the TP1002 submitted is much too loose to permit vertical carriage.

Battery consumption is relatively low, but so is motor power. Fast wind is achieved through so low a gear that the wind speed averages some 9 i/s. In addition to being slow, the take-up is so slack that most tapes were wound eccentrically round the take-up hub. On one occasion, the machine came to a complete stop in mid-wind, despite having been newly fitted with fresh cells.

### REMOVABLE PANEL

Insertion of the batteries, through a removable panel in the base, was comparatively difficult. Unscrewing the panel revealed a cell, one of five positioned in a single row under spring tension. My own moderately long and thin fingers experienced great difficulty in removing the first cell, though once this was out the remaining four were easily grasped. The most effective method of removing cells appears to be the rather clumsy process of turning the recorder base-downwards and giving it a swift vertical shake.

My general reaction to this recorder is one of disappointment. In terms of pure hardware, the TP1002 offers moderate value for money. Despite its stereo facilities, however, it lacks the quality desired by even the most tolerant music lover. More important, it lacks the features that would be expected from a stereo machine by the creative sound or cine enthusiast.

The new TRUVOX Series 50

# THE ONLY TAPE RECORDER THAT GIVES YOU 100 GNS HI-FI SOUND FOR ALMOST HALF THE PRICE!

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## Some of the men behind every New Truvox 50

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**Eddie Maddison and Graham Rolf — Method Engineers** *Found the most efficient way of building the new high-quality tape recorder. This is one reason why you only pay half the price for a 100 gns. sound.*

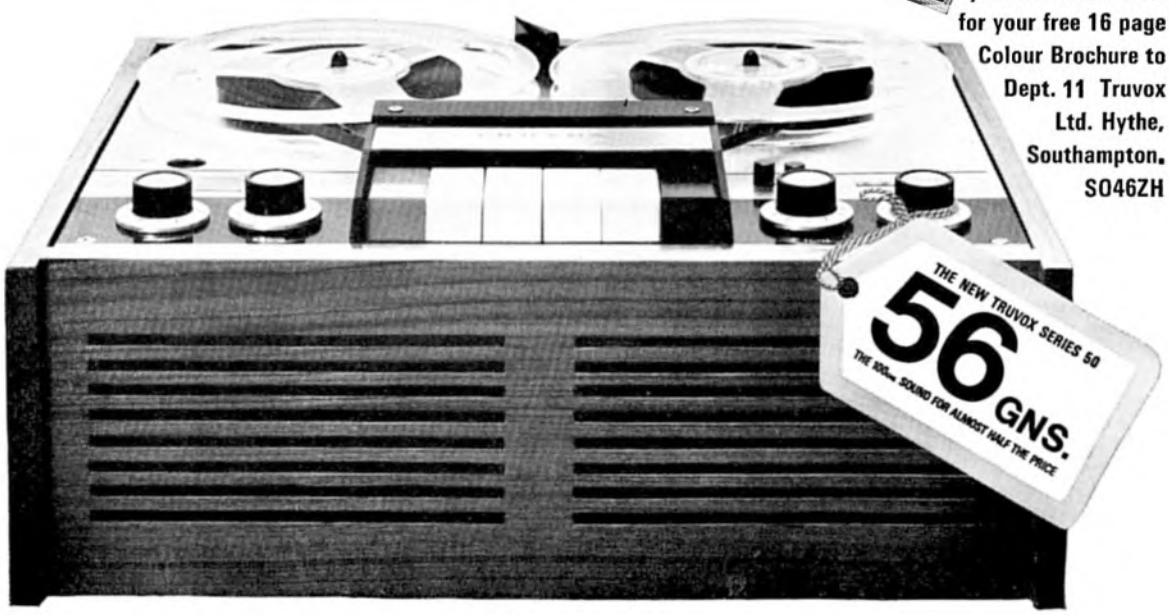
**Gerry Barnes — Production Control** *Gerry ensures that the right parts are fed to the production lines at the right time, at the right place. Productivity remains constantly high. Price remains constantly low.*

**Dave Nicoll — Tester** *Each Truvox 50 tape recorder goes through a chain of 14 stringent tests before it ever leaves the factory. Every Truvox Series 50 has to be completely reliable.*

## The 100 gns. look for almost half the price!

When Truvox make a breakthrough, they make it a complete one. To 100 gns. sound they've added 100 gns. looks – and for almost half the price! The deck of the Series 50, for example, is made by Truvox for Truvox. Precision engineered in every little detail to give perfection in sound and appearance. And nothing but an acoustically-perfect cabinet is good enough for the Series 50. A solid wood cabinet with finest African teak veneers.

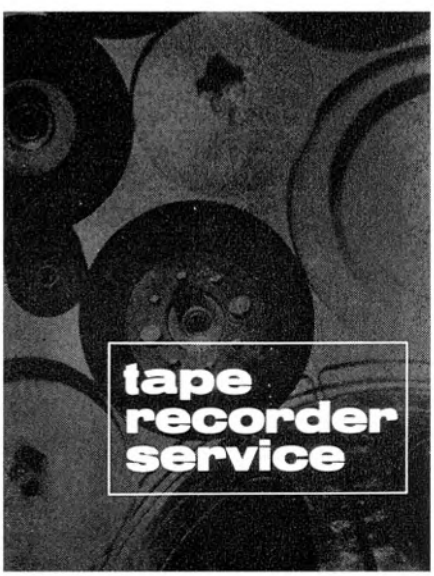
**For details of other products in the Truvox range of Audio equipment ask your dealer or write for your free 16 page Colour Brochure to Dept. 11 Truvox Ltd. Hythe, Southampton. SO46ZH**



We apologise for the omission of the R.10 circuit from this issue. This will appear next month, when Mr. Hellyer continues his coverage of the Reps range.

# REPS R.10

BY H. W. HELLYER




LET me at once declare my interests. In common with many colleagues who know a good thing when they hear it, I am a *Reps* enthusiast. For its basic price of £61 19s (½-track model), the *R.10* represented the best middle-range value on the market when it came out some seven years ago. I should not need to labour the point. What I do want to stress, however, is that the selling points that previously made it good value still hold good, even though machines with more facilities and quite reasonable specifications have been produced at home and abroad at lower prices.

This is not a review, so we shall allow our opinion to be judged by a discussion of the machine. In other words, what do we get for our money?

The R.10 has appeared practically unaltered for years, like several other reliable, good-quality models. But beneath the unchanged exterior small modifications have occurred, from *Mark 1* (early) to *Mark 1* (late) and *Mark 2* in at least three minor variations. There is now a *Mark 3*—although, since Reps have begun to use the *Magnavox 363* deck in place of a Swiss deck produced in limited numbers, this year's model was re-christened the *M10*.

For the former models, the *Collaro Studio* —later becoming *Magnavox Studio*—was the deck employed and modified to Tom Reps' high personal standard. Mr. Reps and his colleague Norman Barnes are the sort of engineer bosses who have long been the backbone of British industry—more likely to be found in shirt-sleeves at the bench than behind the board-room desk. Perhaps that is why they have not made a fortune yet! Talking of them, and visiting the factory, one gets the impression that they begrudge parting with a tape recorder until it reaches a higher standard than economics would allow them to meet.

And a high standard it certainly turns out to be—if one is a discriminating music-lover. The amplifier, feeding 10W (peak) to a 15-ohm loudspeaker, has a frequency response of 20Hz-25kHz ± 2dB. As a tape recorder, the response made possible by the fitting of Bogen heads is still better than usual: 40Hz - 16kHz ± 3dB at the top speed of 7½ i/s, 40Hz-10kHz at 3¾ i/s and 50Hz-6kHz at 1⅞ i/s. Signal-to-noise ratio of the ½-track version at mid-speed is 50dB and of the ¼-track version, 45dB. At the standard 1kHz measurement frequency, and peak recording level, total harmonic distortion is 2%.

Aiding this response and distortion specification is a well-designed tone control circuit whose smooth swing makes it possible for the user to do justice even to some of those atrocious pre-recorded tapes clubbed off to an unsuspecting public. In actual figures, the swing is ± 12dB at 12kHz (treble) and ± 12dB at 50Hz (bass) with reference to 1kHz.

Sensitivity figures of the Mark 1 models were: Microphone 0.4mV to 60mV into 1m, and for Gram or Diode input 60mV to 2V into 1M, both for a fully modulated recording. Output to feed an external amplifier is approximately 1V from a fully modulated tape, this at 600 ohms from a cathode-follower.

Other features are the separate inputs for microphone and gram, each with its individual control—and no interaction, a protected external loudspeaker socket for a 15-ohm unit, push-pull output stages, a push-pull oscillator and a well-damped modulation meter with a sensible amplifier circuit. Record/play selection is relay-controlled, with the selector button for record also acting as a superimpose switch if needed, although this feature is not stressed in the literature, nor labelled on the machine. Some discussion of the relay circuit is necessary, as this is one of the features that may need servicing occasionally. But before we get involved in circuitry, let us take a look at the deck.

The Studio deck has been well covered in the pages of the *Tape Recorder*, both as regards basic servicing (February 1962) and modifications (November 1962 and March 1963), with occasional bursts of correspondence in later years to augment the general information.* Because it is used in a great many machines under a variety of brand names, and because, regrettably, some of those machines left much to be desired, the Studio deck may be regarded with some disdain. But it has a number of features to recommend it, and when slightly modified can give very satisfactory results. The wow and flutter figure for the R.10, 0.1% RMS at 7½ i/s, is an indication of the selection of each deck and its modification to the required standard. The three-motor design does away with the need for belt or idler drives with their ensuing complications, and makes for a really fast and smooth rewind, only a little over a minute for a 7in. spool containing 1200ft. of tape.

At times, this rewind can be too fast, and light plastic spools tend to 'aeroplane', the centrifugal force lifting them. One criticism of the Studio deck that I would make is the lack of spool retainers, such as *Brenell* and *Motek* have found necessary. Our ingenious correspondents have found ways of getting over this, but good design should really have permitted the fitting of standard 'snap-on' spool retainers to overcome a basic fault. The only way to make sure the spool sits tightly is to run a 6 BA screw into the centre 'adjuster' hole of the spool carrier, cut the head off and thread on to it a drilled and tapped plastic knob, with a felt washer glued to its underside. Even then, when some poor quality spools are used, the flanges of the carrier do not grip the spool slots well, and an anti-rattle plug like the Truvox grip would be an advantage.

Reps get over the spillage problem of the Studio deck quite well by adding a pad-brake to the left guide or to the left brake drum. On the type of deck where the motor selection leaves the feed side unpowered during play, some such device is necessary to reduce flutter. The guide pad method is shown in **fig. 2** and the auxiliary brake in **fig. 3**.

As can be seen, the actual mechanism is quite simple, the pad being mounted on a brass arm lightly sprung away from engage-

*(continued on page 509)*

**Ed.*

**Readers are reminded that, while we have few back-numbers prior to December 1966, many of Mr. Hellyer's servicing articles have been revised and published in his book 'Tape Recorder Servicing Manual' published by Newnes at 63s.*

# We'd like you to hear our latest number

## It's the TK145. And it's quite a tape recorder

Grundig have built quality into every inch of this four-track machine. Recording level adjustment is fully automatic, by means of the unique Grundig 'Magic Ear.' This ingenious device acts with split-second precision, and retains natural loudness variations *without distortion.* And when you want it, manual operation is yours at the click of a switch!

The TK145 has a frequency response of up to 12,500 Hz, Wow and flutter below ±0.2%, and a signal to noise ratio of 48 dB. Result? Clean, crisp, *life-size* reproduction.

What's more, you can make synchronised recordings by using the Monitoring Amplifier MA2, and the Earphones type SE3, both available as extras.

There are connecting sockets for recording/playback, monitor headphones and switchable extension loudspeaker. There's even a press-button reset for the position indicator! And—to guarantee cool operation over long periods of playing and recording, the TK145 has the exclusive Grundig single-unit combination of motor and mains transformer.

The uncrushable steel chassis is elegant in teak finish, with a charcoal and silver deck, and silver trim. The TK145 comes with 1,200 ft. of tape and a high-quality dynamic microphone . . . all that for just 47½ gns! Like to hear more? Then send off the coupon *today* for full details of all thirteen Grundig 2 and 4 track tape recorders ranging in price from under 30 gns. to £135.9.0.

**To: Grundig (G.B.) Ltd., Dept. TR1, London, S.E.26.**

Please send me 'The Sound of Grundig' all-colour tape-recorder leaflet ☐ radio leaflet ☐ audio unit and stereogram leaflet ☐ *Tick which you require.*

NAME _____

ADDRESS _____

_____ TR1

GRUNDIG

FIG. 2

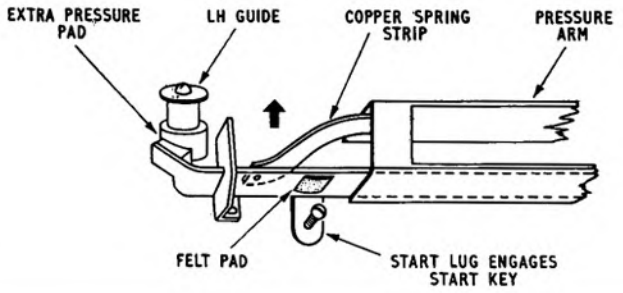
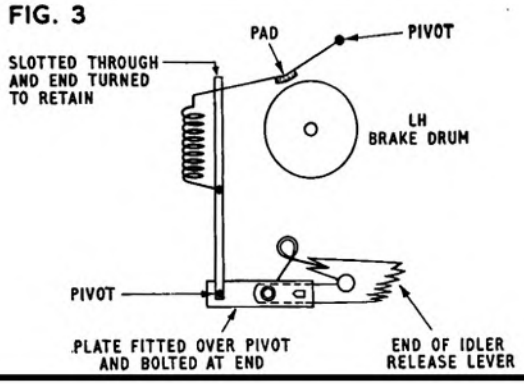



FIG. 3




ment by a copper spring blade. The inner end of the arm is slotted into the pressure arm assembly, but not fastened to it. The arm is free to move inwards when impelled by the bolt head (which, in turn, is moved towards another small pad when the lug beneath the deck is carried inwards by the start mechanism). The angle of the arm is important—sometimes we have had pads riding badly in the guide barrel space and causing more flutter than they were meant to eradicate. This is usually because of maladjustment. The important points to look for are that the screw is not loose in the lug and that the arm is riding cleanly in the support bracket.

Talk of guides brings us to one of the most common faults, with perhaps the simplest cure, in the calendar of tape recorder service. This is a trapping of tape oxide in the angle between barrel and flange of the type of guide used in this and many other decks. Regular cleaning does not always get at this deposit. Methylated or surgical spirit, or one of the proprietary tape cleaners, softens oxide and releases it from smooth surfaces and a little diligent brushing will produce what appears to be a spick-and-span deck. But with the aid of a dental mirror and a bright light, a very thin line of brown can be seen trapped in the upper cornice of the guide.

There are two ways of getting it out. Toothpick or towel-rub, as one of my colleagues remarks . . . One can sharpen the end of an orange stick and dig away with care. Better still, use the 'scrubbing-brush' of the new *Bib* kit, or one of the *Tape Recorder Spares* angled head-brushes. Alternatively, one can use a strip of linen tape, such as considerately supplied with some machines by Messrs. *Sony*, damp it lightly with spirit and then use the same type of movement with which you towel your back after a shower. The fairly stiff edge of new linen tape gets nicely into the angle. Leaving any oxide at this point inevitably leads to a later build-up. The symtoms are often pronounced flutter, curl of anything thinner than double-play tape, and even, in advanced cases, slowing down of the tape during fast wind.

Apropos of this, some machines, such as *Grundig*, *Telefunken* and *Philips*, have similar machined guides. It seems to be those which use a combination of chromed or polished-steel barrel and brass body that are most prone to this fault. On simpler decks, such as the early *BSR* models, brass pins are used as a form of guide. The auto-stop feeler pin on some Telefunken machines and the guide pin on some Philips decks, also brass, will tend to wear into a very neat step which traps the tape edge in the same way. (Come to that, so does the tape wear a nasty step in many types of head facing, contributing to expensive repair bills.) *Philips* ¼-track heads of the immediate past generation of machines were particularly prone to this; the symptoms were reduced sensitivity, more at the upper end of the frequency range, on Track 1 especially.

Unfair to Reps—I hear someone call. It is true that the only cases we have seen of the Bogen heads employed by this company wearing in this way have been traced to the use of cheap tape. If I may be excused a sermon : we never really get something for nothing. Eventually, we pay ! And the use of cheap tape that may appear to work very well indeed can cause this abrasive action—by the time it is noticed, it is too late.

On to the auxiliary brake. **Fig. 3** shows the general layout of this, which engages the feed spool drum when the start key is depressed. Brass levers are employed, the lower plate slotting neatly over the end of the bush that holds the pivot of the release fork lever for the idler support arm. The long arm is taken along the left side, just beneath the deck-plate, and is slotted through the brake arm, and sprung to it, tending to hold the pad 'On' when the machine is in record or play mode. On some of the earlier models, the end of the long lever was not bent and it tended to come adrift when the machine was up-ended, as during service. It needs only a twist with a large pair of pliers to cure this tendency.

The brake drum must be clean and the pad fairly soft to ensure good unspooling without any snatch. But the usual reason for this snatching fault is a worn or 'sticky' brake band. Servo brakes are necessary on fast-running three-motor decks, and these are a treated fabric which can age. Replacements are quite cheap, and not difficult to fit. Avoid engaging brakes immediately after cleaning the drums—they do not like the taste of spirits.

While on the subject of brake drums and spool carriers, one of the main faults for which Reps have come in (not by any means common, but relatively speaking a Studio deck fault) is a habit of slowing down towards the end of wind or rewind, more marked when the machine gets hot. Sometimes, motors are suspected. More often, it is simpler than this. The trouble is generally a slackening of the spool carrier on the motor spindle. The carrier is of alloy construction, with case-hardened screws or bolts ; the spindle is of very hard steel. The different co-efficients of expansion cause the effect. It is good general practice to tighten when the machine is hot. But there is a snag.

Of the numerous production runs of Studio decks, Reps have employed three main types. These have either a one-piece spool carrier with axial screws reached through holes in the drum and needing a good screwdriver with fairly thick-ended blade to make the screws bite, or one of two sectional carriers. The type with three screws in the top and a central threaded hole for adjustment of the carrier height, and the type with a cylindrical bore and a bush which clamps over this by two 6 BA bolts. It is this last which gives the most bother. Tighten it up and some hours later it may very well work itself loose again. So we remove the carrier, remove the bush, saw a slot in the bore piece with a Junior hacksaw and reassemble, remembering to blow all the swarf away ! This allows the bolts to clamp the bore inwards and grip the spindle. If the toolkit does not run to a good 6 BA box spanner, slot the screw-heads while the bush is adrift and use a good screwdriver to reassemble.

The height of the spool carrier is important. Remember, when assembling, that the motor tends to throw its spindle upwards when run up to speed. Set height with a loaded spool so that the tape runs out evenly to the adjacent guide. Make sure the spindle is vertical by turning the motor by hand (at the drum—a one-finger exercise) and noting any rocking action of a 7in. spool. Level by adjusting

*(continued on page 511)*

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| 88 STANDARD PLAY | 100 DOUBLE PLAY |
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EMI TAPE LIMITED HAYES MIDDLESEX ENGLAND

# OUR READERS WRITE . . .

### . . . about an adjustable guide

**From : D. J. Shaw, 4 Higher Redgate, Tiverton, Devon.**

*Dear Sir*, Your readers may be interested in a simple gadget for preventing tape fouling the edge of warped spools. An adjustable guide can be made up from the suction-base of a *Dust Bug*, together with an ordinary wire paper clip of medium size. The diagram shows the bending procedure involved, vertical adjustment being achieved with the small screw on the suction pillar. The rod of the Dust Bug is not used.

I do not use a Dust Bug now for my gramophone records, as I have a *Preener*. The purer atmosphere of Devon, no smoking in the house, and a *Perspex* cover, are other reasons for not using it.

*Yours faithfully*

### . . . about not wasting your money

**From : Philip Keates, 10 Hollyshaw Grove, Leeds 15.**

*Dear Sir*, Peter Turner advises the beginner to think carefully before buying his first tape recorder, and then to buy a high quality machine. Looking back over a decade of experience, he can now see what he might have bought at the start to last him through the years. But this is precisely what a beginner cannot do. The various applications of tape recording require different sorts of equipment and, until the beginner has explored the field of opportunity for himself he cannot possibly tell whether his eventual interests will be best served by a massive stay-at-home model, by a lightweight good-quality recorder with which to tour clubs and old people's homes, or perhaps a first rate battery portable for location recording.

May I suggest that the beginner should buy the cheapest recorder which will meet his foreseeable needs, provided it is backed by adequate service, and learn by his own experience what sort of machine he will ultimately prefer. He would certainly be unwise to reject stereo on Mr. Turner's advice alone !

*Yours faithfully*

### . . . about wow and flutter again

**From : W. H. Myall, Sydney House, 35 Villiers Road, Watford, Hertfordshire.**

*Dear Sir*, In reply to the letter from Mr. Lennard (October issue) on my recent article, it was reassuring to see 'A Close Look at Wow and Flutter' described as easy to follow by at least one reader.

Regarding the 3kHz carrier frequency, I do not think I described this as a standard. As was explained further on, it is in no way related to the wobble and an arbitrary choice would have suited the purpose just as well. 3kHz was chosen almost without thought simply because it has been regarded as something of a standard (if unofficially) for several decades. It became recommended by the BSI in 1953.

Whatever carrier frequency is used, it remains highly desirable that the measuring device should not be too critical of frequency within a few per cent, as one can then use a pre-recorded tape (or disc) without regard for the absolute speed of the machine or for drift during the test. By the same token it can cope with either 3kHz or 3.15kHz. The fact that Mr. Lennard's flutter meter can be switched to suit either frequency suggests that the makers themselves have been obliged to accept that the earlier standard is somewhat reluctant to die.

*Yours faithfully*

*"I hate these Minicassette sessions"*

the 4 BA Simmonds nuts on the spring-loaded plate of the motor mounting. Remember that this is a three-point suspension ; adjustments should be counter-checked.

And so to the relay circuit. The circuit shown (**fig. 1**) is common to the R10 range, but there were minor variations, mainly because of the original trouble of relays reverting to record during the play mode if there was a momentary interruption of supply. An explanation of the operation will show how this could happen, and give a hint toward checking of the relay operation. The relay needs about 32V DC to pull in, and a figure of about 40V is generally supplied as a holding voltage, via the 33K 2W resistor when the relay is closed during play. When the start key is pressed, HT of 270V is available at the upper section of the start switch. This is linked to the lower section and applied to the relay coil via the unmoved record switch and the 220-ohm resistor. Contact set R4 changes over and the upper section of the start switch is now closed so that HT is applied via this section, contacts 2 and 3 of R4 and the 33K holding resistor. The lower section of the start switch has completed its movement and is now open. The full HT link is broken.

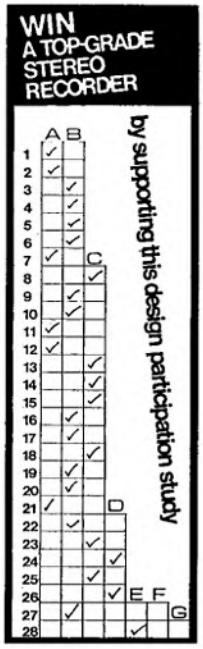
The fault that can happen is a loose lower contact which receives full HT all the time, arcs, and upsets the slide section of the switch as the metal burrs over and fouls. Rare, but baffling the first time it occurs.

To select record, the record button is first depressed, then the start key, so that the relay does not receive sufficient voltage to pull it in, contacts 1 and 2 of R4 being 'made' and the record key contacts now interrupted. The key is released and the right-hand pair of contacts provides HT for the oscillator and meter amplifier circuit. Thus, as record is operating, subsequent depression of the record button affords a superimpose facility by removing HT from the oscillator.

Later models had the 220-ohm resistor changed to 1K and still a large pull-in pulse was needed, but as the Mark II came along, the relay circuit was redesigned slightly and several other changes were added to be shown in next month's circuit. The DC resistance of this relay, incidentally, is about 5.6K. If any difficulty is found in the closing function, when play is selected, it may be necessary to shunt the 33K with about 100K ; do not try to improve matters by altering the contacts. Gentle cleaning is all that is normally necessary. The locknutted adjuster screw should not be touched.

Note the provision of the suppressor components across all voltage-breaking switches here and on the motor circuit. This is one of the modifications to the Studio deck which could well improve many other machines, and illustrates the thought that goes into Reps design. Many of the points on the given circuit are common to later Mark I and the Mark II models, and will be discussed next month.

In closing this section, I should mention the use of a Prescollan speed idler, which makes that final improvement in the wow and flutter figure, and may justify the relatively high cost if really serious listening is your aim. These do not suffer from the 'scuffing' that can quickly damage the normal rubber idlers with this type of engagement. Your Reps dealer would probably do an idler replacement and complete speed check and adjustment job for about £5 while these idlers can still be supplied. It is a modification well worth consideration.




# report on the september tape recorder design study

A RESOUNDING success—our reaction to the enormous response achieved by the Design Participation Study published in our September issue. The number of replies from readers amounted to over 14% of our circulation, 4% above the Questionnaire which appeared in April.

Two reasons can be seen for this success: the prize of a *Ferrograph* stereo recorder for the contributor of the entry judged to be optimum, and the great interest among our readers in showing, once and for all, just what they desire in a tape machine.

The judges were deliberately vague in asking for "the most nearly optimum specification for a high quality recorder". They wanted, as do many manufacturers, the specification of a recorder that would satisfy the demands of the major part of the 'semi-professional' market—catering equally for the music-lover and the creative recording enthusiast. In this sense, therefore, the judging revolved on more concrete foundations than the more-or-less well-informed opinions of the individuals involved. Personal whim was cast completely aside and a precise statistical breakdown of the thousands of entries was prepared. From this breakdown a single 'ideal' design emerged. Every entry was then examined a second time and compared in detail with the 'ideal' answer. No reader actually managed to supply all 28 of the desired answers, most achieving permutations of 16 or 17 'correct' answers.

At the top of the list were four questionnaires, each containing answers conforming to 24 of the ideal 28. At this point the questions still in dispute were listed in order of importance by the judges, again averaging their opinions democratically on paper, and

Gordon Van Beck, winner of the Tape Recorder Design Study, is eighteen and works for the Ministry of Social Security in Edinburgh. His present recorder is used for tape correspondence and to assist night-school study of French. He had "quite resigned" himself "to reading about some other lucky winner in the December issue."

in this way the clear winner was found—Mr. G. Van Beck of Edinburgh.

So much for the mechanics of judging. What, in fact, is the specification that *Tape Recorder* readers, on average, would like to see? We are pleased to say that it is a sensible and realistic one. No plea for 10½in. spools with lid down, for example, and no demand for excessive facilities at an impractical price. Mr. Van Beck would pay 105 gns. for his mono machine and 150 gns. for the stereo version. If the price difference between models seems too high, remember that his stereo recorder, like our readers' ideal, would have two sustained PPM's and two internal 5W monitor amplifiers. Let us stop nibbling at the *hors-d'oeuvre*, however, and settle down to the main meal.

**(1)** The first of the twenty questions in the study concerned the disposition of amplifiers and controls. Assuming vertical operation, readers favoured *broad and low* styling to a *narrow and tall* disposition. They did so, as will be seen from the percentage breakdown, by a substantial 75%.

**(2)** Readers preferred a *functional instrument presentation* by 73% to a *domestic furniture approach.*

**(3)** The clear majority felt that accessory stowage space *should not be provided.*

**(4)** Fine adjustment of fast-wind speed and direction was marginally considered *unnecessary* in the sense that it did not warrant the cost of its inclusion.

**(5)** Strong views were apparent on the subject of automatic threading, which was regarded by 79% as *non-essential.* (Mr. Van Beck differed from the ideal, here, and we would risk mass condemnation by agreeing with him. A logical simplification of tape-threading could be achieved around the idea developed for the *Ampex 2000.* If their slit-hub take-up spool was transferred to the immediate-right of the heads and capstan, genuine 'straight-line' threading would become possible without need for mechanical intricacy.)

**(6)** Readers desired automatic stop, not merely on *record and replay* but on *record, playback and rewind functions.*

**(7)** The cost of duplicating the meter system (PPM—see Question 25) was most certainly *warranted.*

**(8)** It was perhaps predictable that readers should want their machine designed to *operate equally well in both planes* though we would remind them of the comments expressed in the past by Messrs. Norman Leevers and Tom Reps. The former gentleman could not envisage a theoretically perfect tape transport being anything other than a horizontal design. Mr. Reps made a more general point: decks can be designed to perform at their best in horizontal *or* vertical positions but a design capable of functioning in *both* planes must

---

**1. Form.** The disposition of the various amplifiers and controls, i.e. beneath, or at the side of the mechanical section, can affect the relative overall dimensions. The preferred disposition assuming vertical operation, shall favour a form which is—
- A. *broad and low* (75%)
- B. *narrow and tall* (25%)

**2. Styling.** The styling shall favour—
- A. *a functional instrument presentation* (73%)
- B. *a domestic furniture approach* (27%)

**3. Accessory Stowage.** Space for the storage of principal accessories, i.e. microphones, etc.—
- A. *should be provided* (39%)
- B. *should not be provided* (61%)

**4. Rewind Control.** Having selected the fastwind function, an additional control for the fine adjustment of rewind speed and direction—
- A. *shall be provided* (41%)
- B. *is unnecessary* (59%)

**5. Loading.** Automatic threading of the tape is—
- A. *highly desirable* (21%)
- B. *non-essential* (79%)

**6. Automatic stop.** Automatic stop arrangements are necessary on—
- A. *record and replay functions only* (32%)
- B. *record, playback and rewind* (68%)

**7. Stereo monitoring.** The cost of duplicating the meter system on each channel of a stereo recorder as opposed to one switched system is—
- A. *warranted* (74%)
- B. *unwarranted* (26%)

**8. Mounting.** The recorder shall be designed—
- A. *for horizontal operation (lying flat, deck plate horizontal)* (31%)
- B. *for vertical operation (deck plate vertical)* (5%)
- C. *to operate equally well in both planes* (64%)

**9. Cabinets.** The recorder shall be contained in a case of—
- A. *natural wood for a predominantly static role* (29%)
- B. *natural wood in a basically portable form* (53%)
- C. *plastic or plastic-covered general purpose case* (18%)

**10. Colour.** On the basis of a restricted colour choice the preferred colour scheme for the deck and panel is—
- A. *black and silver* (35%)
- B. *two-tone grey* (59%)
- C. *bronze derivatives* (6%)

**11. Inbuilding.** The placement of controls, socket access, etc., shall allow inbuilding into existing cabinets or systems by—
- A. *easy removal of the mechanics and electronics as a discreet unit from its own case* (43%)
- B. *inclusion with case complete* (42%)
- C. *inbuilding facility is unimportant* (15%)

**12. Transparent Cover.** A rigid transparent plastic cover should be available—
- A. *as a dust cover for the equipment when not in use* (56%)
- B. *as a cover for the mechanical unit while operating* (22%) (see Question 23) *or*
- C. *provision of a cover is unimportant* (22%)

**13. Reel Sizes.** Bearing in mind the availability of long play tapes, the maximum reel diameter which should be accommodated is—
- A. 10½*in.* (15%)
- B. 8½*in.* (42%)
- C. 7*in.* (43%)

**14. Rewind time.** The preferred rewind time for a 1,200ft. reel of standard thickness tape is—
- A. *approx.* 3 *mins.* (6%)
- B. *approx.* 2 *mins.* (46%)
- C. *approx.* 1 *min.* (48%)

**15. Indexing.** Position-finding along the length of the tape shall be provided by means of—
- A. *a clock-type counter registering reel turns* (15%)
- B. *a digital counter registering reel turns* (29%)
- C. *a tape footage counter* (56%)

**16. Controls.** The most desirable means of accommodating stereo controls is by—
- A. *two completely separate amplifier panels each with its individual controls and meter* (43%)
- B. *a single amplifier panel with concentric dual controls and meters* (44%)
- C. *a single panel with ganged controls* (13%)

necessarily be a compromise. It would be interesting to hear the *Ferrograph/Revox/Truvox* views on this matter. In the meantime, we draw attention to the mere 6% demand for a vertical-only machine.

**(9)** Combining this reply with that of Question 2, we find a machine of functional instrument presentation housed in *natural wood of basically portable form.*

**(10)** A general preference was expressed for *two tone grey*, of the conservative colour choice offered. More surprising than this, however, is the extreme lack of support for *bronze derivatives.* Manufacturers, too, appear to dislike this finish, presumably due to its suggestion of brash 'imitation gold'.

**(11)** Our readership is split, here, between the hi-fi stay-at-homes and may-want-to-travel creative individuals. It would seem easy enough to satisfy both **A** and **B** customers with a plinth-mounted integrated recorder having detachable screw-in side-facing handles and foot-studs.

**(12)** Aesthetics again. Readers desiring a rigid transparent plastic dust cover for the equipment *when not in use* probably comprise owners of plinth mounted machines that are now supplied, almost as a matter of course, without any form of cover. Equally, a wooden lid on a modern semi-professional recorder creates a somewhat bald 'suitcase' image that does not lend itself to living-room decor.

**(13)** Since the specified recorder lacks a 15 i/s speed, the choice of a 7in. spool capacity seems a sensible one. Almost equal demand exists, however, for a machine of 8½in. capacity —which would conform to *Ferrograph* and *Brenell* thinking. This larger capacity certainly simplifies matters when 7½ i/s copies are required of broadcast concerts and the like.

**(14)** Indecision, once more, between very fast winding speeds and a moderately fast but, one hopes, neater wind. Observe the great unpopularity of the 3 minute rewind (7in. standard play), suggesting disenchantment with certain single-motor mechanisms.

**(15)** Substantial demand exists for a more meaningful and accurate indexing device than the almost universal turns counter. The *tape footage counter* chosen by 56% of readers would be expensive but, particularly if gauged to read minutes and seconds, would be an obvious sales attraction. *How* expensive, one wonders?

**(16)** Almost equal demand exists for the *separate-channel/separate panel* style of the *Vortexion CBL* and *Akai M8* and the integrated *concentric dual controls and meter(s)* of the *Ferrograph 632.* The preference is for the latter, by 1%, though Mr. Van Beck is among the promoters of style **A.**

**(17)** Tone controls giving *bass-cut-and-lift and treble-cut-and-lift* are desired for the fairly elaborate internal amplifier readers require. By a margin of 3%, there appears to be an opinion that purely attenuative tone controls are worse than useless.

**(18)** This reply reflects a grave concern among readers over the problem of matching bias to suit tape and speed. *Variable bias with meter indication* would be a worthwhile step out of a confused situation, provided meter graduations were referred to particular tape brands or characteristics.

**(19)** 58% of 'ideal machines' would see service in wider realms than simple recording from tuner, tape or disc and the minor expense of *mic* and *gram* mixing facilities is generally agreed to be worthwhile.

**(20)** However tempting reply **C** might have been, 67% of readers would not expect to be using their machines after ten years of working life. A pleasantly sensible response with an equally pleasing condemnation of the five-year-domestics of which most of us have bitter experience.

**(21)** £5 per annum is generally regarded as a reasonable upkeep for a £100 recorder. Even the best of machines, we feel, would probably deserve £10 in new heads and minor parts after the first three or four years but only 4% of readers would readily pay more than this figure.

**(22)** Reduced to whole figures, the balance of opinion between 40lb. and 50lb. maximum weights stands at an equal 32%. Only 2% separates the marginally correct answer **B** (40lb. maximum) from the 30% view that weight is *unimportant.* The suspicious regard for lightweight machines is likely to remain with us for many years as implying fragility.

**(23)** Only 2% of replies to this question fell into the 'lunatic fringe' demanding 10½in. capacity with the lid closed. Readers do not, in general, wish to remove 7in. spools before closing the lid of their machines.

**(24)** 37% of readers accept that stereo cannot be obtained, even at monitoring quality, from loudspeakers within the limited cubic volume of a tape recorder cabinet. "Supplied separately" was intended to mean, in effect, "optional, at extra cost" but we suspect that readers assumed a pair of simple units would be supplied in small cabinets, following the practice set by *Bang & Olufsen.*

**(25)** The judges were particularly gratified to see that the advantages of the peak programme meter were generally realised. *Tandberg* might rightly complain of the poor regard in which the magic-eye is apparently held, for a well-designed magic-eye is theoretically preferable even to a PPM. In fact, however, the PPM has always proved easier to read, if only by virtue of its larger scale. Strange, but even AGC is more popular than the magic eye.

**(26)** *At some increased cost, a comprehensive manual with full technical and servicing information* would be favoured by a substantial 73% of readers. Are *Ferrograph* alone in catering for this very reasonable demand?

**(27)** The greatest fraction of replies to the question of outputs expressed a desire for twin 5W monitor amplifiers—something more substantial than a pair of simple monitors.

**(28)** We would like to say that demand for 15 i/s as a third speed was at least equal to that for 1⅞ i/s—but it was not. 40% of readers voted for the inclusion of *7½, 3¾* and *1⅞ i/s* with 28% reflecting the second choice of *15, 7½ and 3¾ i/s.* Mr. Van Beck, in addition to sensibly selecting switched bias in Question 18, was among the 2% minority requiring 15/16 i/s in item 28 G. We were disappointed to note the very poor following for *15 and 7½ i/s* speeds but are gratified that even this exceeded the mere 1% who would be content with *3¾ and 1⅞ i/s.*

While not wishing to appear pandering towards *Ferrograph* for supplying the prize that helped attract so gratifying a response from readers, we wish we had resources enabling us to offer their Managing Director, Mr. R. W. Merrick, one of his own *632H* machines as a reciprocal presentation. For there can be no doubt that the current Ferrographs come closer to our readers' ideal than any other machine in existence. What more can one say?

---

**17. Tone Controls.** These shall be fitted on each channel to provide for—
- **A.** *bass-cut and treble-cut only* **(15%)**
- **B.** *bass-cut-and-lift and treble-cut-and-lift* **(67%)**
- **C.** *inbuilt tone controls are unnecessary* **(18%)**

**18. Bias Adjustment.** Variable bias control shall be—
- **A.** *omitted (bias fixed)* **(18%)**
- **B.** *variable in two steps for the main tape categories* **(37%)**
- **C.** *continuously variable with meter indication* **(45%)**

**19. Mixing.** The ability to mix with independent gain controls shall be provided as follows—
- **A.** *no mixing required* **(10%)**
- **B.** *two inputs, i.e. microphone and radio* **(58%)**
- **C.** *three inputs* **(32%)**

**20. Life.** The normal useful working life envisaged for the machine shall be—
- **A.** *5 years* **(7%)**
- **B.** *10 years* **(67%)**
- **C.** *15 years* **(26%)**

**21. Maintenance.** The general engineering standard of the machine shall be such that after the expiry of the guarantee period, the overall annual maintenance cost as a percentage of its original cost should not exceed—
- **A.** 5% **(64%)**
- **B.** 10% **(32%)**
- **C.** 15% **(4%)**

**22. Weight.** Having regard to the subsequent performance requirements, the weight should not exceed—
- **A.** *30lb.* **(6%)**
- **B.** *40lb.* **(32%)**
- **C.** *50lb.* **(32%)**
- **D.** *unimportant* **(30%)**

**23. Overall size.** Having regard to 13, smaller case sizes may require some reel diameters to overhang. It should be possible to close the lid for stowing or carrying with the following reels in position—
- **A.** *10½in.* **(2%)**
- **B.** *8½in.* **(19%)**
- **C.** *7in.* **(61%)**
- **D.** *all reels removed* **(18%)**

**24. Loudspeakers.** In the case of stereo machines having power output stages, loudspeakers shall be provided as follows—
- **A.** *none* **(9%)**
- **B.** *one switchable to either channel or both* **(30%)**
- **C.** *two speakers, one for each channel, inbuilt* **(24%)**
- **D.** *two speakers, as matching units, supplied separately* **(37%)**

**25. Recording Level/Monitor.** The recording level shall be monitored by—
- **A.** *magic eye* **(6%)**
- **B.** *VU-meter* **(39%)**
- **C.** *sustained peak programme meter* **(48%)**
- **D.** *automatic electronic control* **(7%)**

**26. Operating Instructions.** A handbook shall be provided. In addition to simple operating instructions it shall contain—
- **A.** *no additional information* **(1%)**
- **B.** *advice on recording techniques, i.e. microphone-placement, etc.* **(12%)**
- **C.** *technical data on the instrument in lieu of recording techniques* **(14%)**
- **D.** *at some increased cost, a comprehensive manual with full technical and servicing information* **(73%)**

**27. Outputs.** Bearing in mind cost factors and possible ownership of other amplifier systems, the principal output power of each channel shall be—
- **A.** *2W* **(12%)**
- **B.** *5W* **(46%)**
- **C.** *10W* **(13%)**
- **D.** *20W* **(2%)**
- **E.** *at low-level* (1V) only **(5%)**
- **F.** *low-level with simple single monitor stage* **(22%)**

**28. Operating Speeds.** The number and range of operating speeds shall be—
- **A.** *15 and 7½ i/s* **(2%)**
- **B.** *7½ and 3¾ i/s* **(14%)**
- **C.** *3¾ and 1⅞ i/s* **(1%)**
- **D.** *15, 7½ and 3¾ i/s* **(28%)**
- **E.** *7½, 3¾ and 1⅞ i/s* **(40%)**
- **F.** *15, 7½, 3¾, and 1⅞ i/s* **(13%)**
- **G.** *7½, 3¾, 1⅞ and 15/16 i/s* **(2%)**

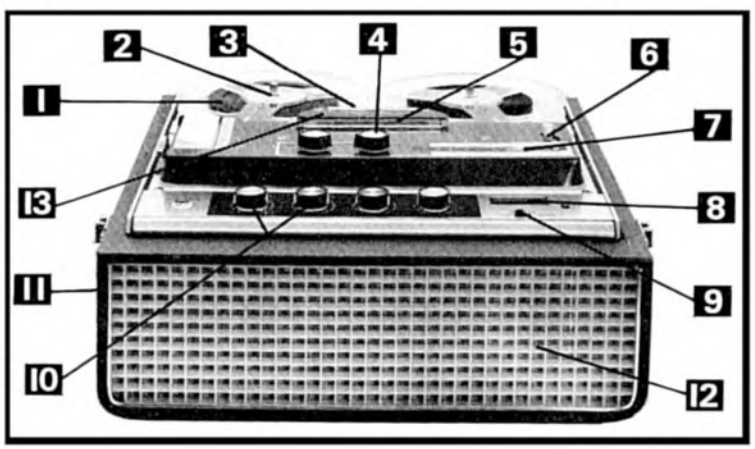
Jerry Keebles: 2nd violin

# What knobs does he turn to become 1st violin?

To Jerry, his violin is his living. And he's a superb violinist. But not the best. *Yet*. So when he's not playing before thousands, he's practising before his Truvox 100 Tape Recorder. He plays, then turns a knob, *and learns*. The Truvox 100 is the only tape recorder for Jerry. If you can catch him in a spare moment, he'll be glad to give you the reasons, button by button 1 7" spools 2 Spool clamping 3 Duo play and Multiplay (R 104) 4 3 speeds 5 Built-in splicing flap 6 Cue and inching control 7 Push button reset 4 Digit counter 8 Accurate V.U. Recording Meter 9 Tape/Source A–B monitor switch 10 Mic/Radio/PU mixing 11 Solid wood cabinet covered with tough washable P.V.C. 12 8" x 5" loudspeaker 13 3 heads

**And there are a few features without buttons that make the R 104 Jerry's choice. Like Solid state all-silicon transistor circuitry/Pre amplifier output fully variable 0–1 volt/3-motor Truvox Tape Deck/Separate record and playback heads/Micro-switch deck operation/Also available – Belgravia model finished in selected teak veneers.**

Jerry Keebels is a professional musician. So he simply can't afford anything less than the reproduction of the Truvox 100. **Prices** R 102 (two track) R 104 (four track) 89 gns. Belgravia model 93 gns.

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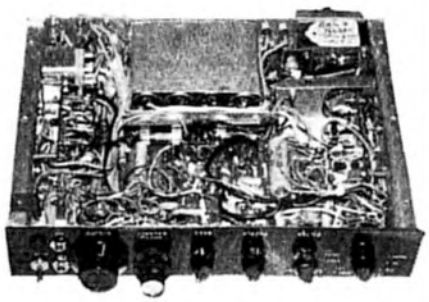
# THE PINT POT



## A VERSATILE TRANSISTOR AMPLIFIER

BY JOHN FISHER

THE amplifier to be described may be of particular interest to tape recorder users as it was designed and built with recording requirements very much in mind. Firstly, it was required to be of high quality, and to accept a variety of signals with provision for equalising, tone control and filtering, with a wide dynamic range in the preamps to cater for exceptional signal levels without overloading before the volume control. Secondly, it had to be compact and portable, for use at live recording sessions as a monitor stereo or mono amplifier. Thirdly, it was required to produce enough power to drive loudspeakers at reasonable listening levels at home and when recording; the nominal 10W Dinsdale 15-ohm transistor design seemed a reasonable choice, to drive my *Goodmans Maxims* whose nominal power rating is 8W, and other speakers in use. Fourthly, the preamp stages were required to provide a low impedance output for recording, to avoid hum pick-up and high frequency losses, and to facilitate matching to a variety of input impedances of tape recorders; this output was to be before the tone and filter controls to avoid the recording being influenced by the settings of these controls. To avoid problems from earth loops the output was to be floating with respect to amplifier earth, so the output to tape recorder needed to be transformer fed. Fifthly, the amplifier was required to accept an input, at high impedance, to the control stages at the same time as feeding the *selected* output to the tape recorder so that without unplugging, a signal can be fed from, say, the tuner input via the preamp to the tape recorder, and the control and power amplifiers used to monitor the recording off tape. Sixthly, in addition to the normal balance control and stereo/mono switch, a width or blend control was required to narrow recordings which sound too left-and-right and have a hole-in-the-middle, or to compensate to some degree for the speakers being (necessarily) placed too far apart in one particular room.

Transistors are attractive for preamp stages offering very low noise levels; this is particularly true of silicon transistors which also ease the problems of providing a high input impedance in a transistor amplifier. While valve power amplifiers can offer very good power performance, it is generally more convenient now to use transistors which can offer a performance adequate for listening as opposed to measuring exercises. Transistors are much more compact, more efficient, competitive in price, and more easily used in a small integrated amplifier. Several designs for high quality transistor power amplifiers have been published; the Tobey-Dinsdale design has been widely used in a variety of forms and, being well tried, was used here. As silicon transistors have become available very cheaply some re-design of preamp and tone control circuits was worthwhile, particularly as these had anyway to cope with the output/input requirements for recording, and maximum dynamic range was required.

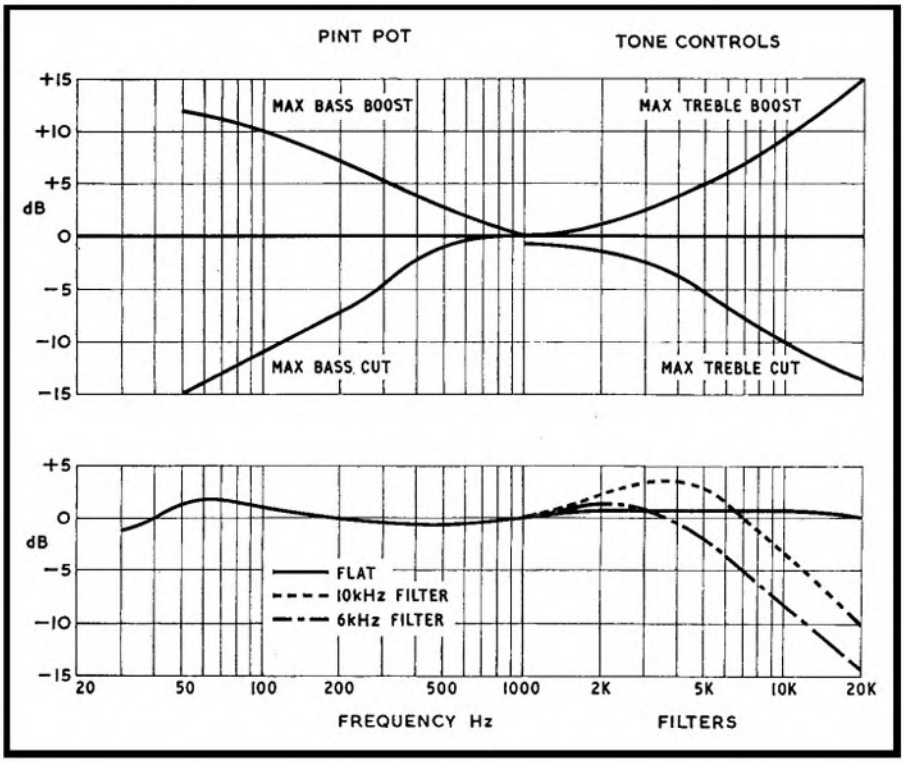
As mentioned, the amplifier has to be used at home, as well as on live recording sessions. Originally it was intended to fit under a *Garrard SP25* turntable, on a small plinth, and this rather dictated the size and shape of the whole amplifier. However a *Garrard 301* turntable was acquired before the amplifier was finished, so that there is rather more room under the motor board for the amplifier, which fits into a recess 2in. deep, with a 5in. gap beside it to house a transistorised FM tuner.

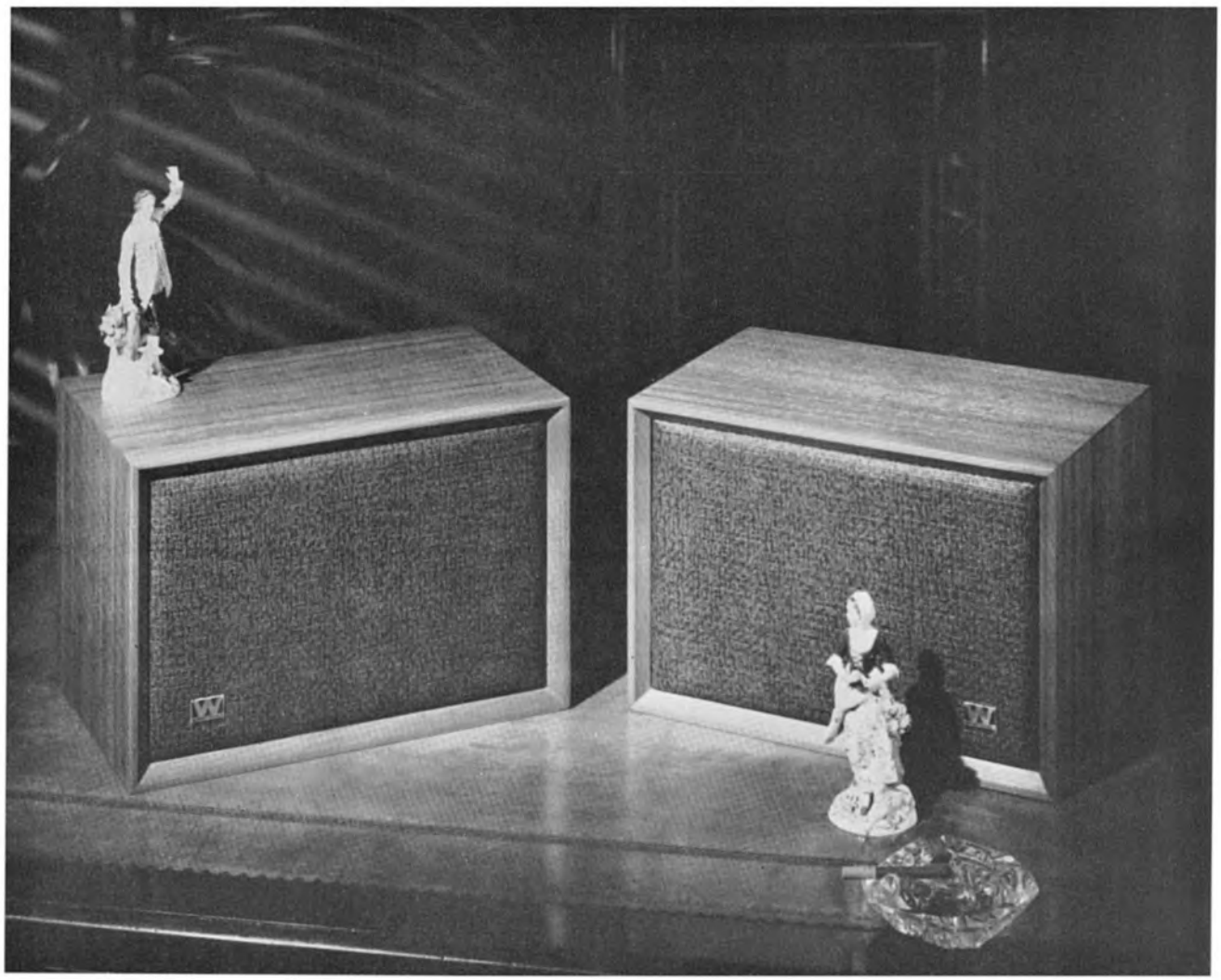
Inputs to the preamp stages are via coaxial sockets, with damping or shunt resistors across each socket. The inputs are taken through light-weight co-ax to the selector switch wafer. The inputs not in use are not earthed, but no trouble from breakthrough of signals from other channels has been found. From the switch the signal goes to the base of the first transistor via a 0.2μF polyester capacitor, and the channels can be paralleled by the stereo/mono switch; this is preferable to paralleling at a later stage in the amplifier as it loads the inputs of both channels and thereby avoids noise from an open-circuit input.

The first transistor is directly coupled to the second, providing the bass bias of the latter. The two together form a DC feedback pair, which stabilises their working points. The output from the pair feeds an emitter-follower stage, which simplifies the provision of adequate feedback for frequency correction for magnetic pickups, tape heads, etc. (see Dr. A. R. Bailey, 'High Performance Transistor Amplifier' Part Two, *Wireless World* December 1966), and provides a low output impedance to drive the line output transformers. A resistor is included in series with the transformer primary to avoid loading the output severely if the output is shorted (e.g. by a two-contact jack plug used for a single channel output) and to avoid damage to the emitter-follower transistor from large amplitude very low frequency surges.

AC feedback is applied across the 1.2K

(*continued on page 517*)





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resistor between the emitter of the first transistor and earth, and provides a very high input impedance, which is padded out to the required value, by the resistors across the inputs. The values for the feedback components for RIAA and 78 r.p.m. disc were derived from the Dinsdale preamp, with the feedback capacitors for HF roll-off adjusted on test to give the closest similarity to the theoretical RIAA curves. An extra compensation characteristic (LP2) is provided, which gives lower bass, and higher treble turnover frequencies than the RIAA curve; this has been found useful with certain discs which sound dull or plummy with the normal compensation, including some from the cheap labels and some acetates and small-batch discs from private tapes. In addition, a position is provided with compensation for crystal or ceramic pickups; these devices are largely capacitive, and feeding into the relatively low impedance (47K) require bass lift to compensate the resulting 6dB per octave fall-off.

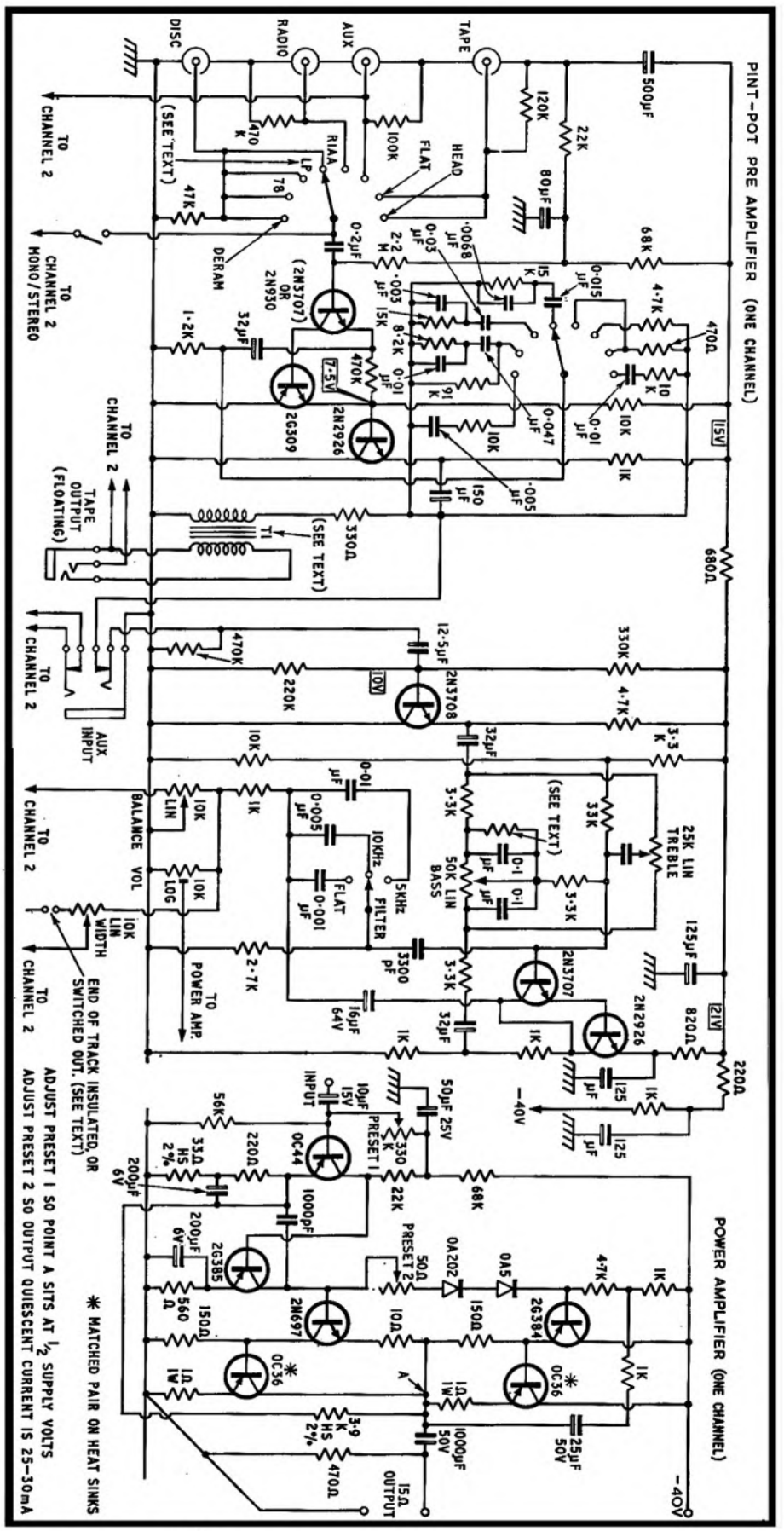
Non-selective feedback is provided for radio input (from a stereo decoder) giving a small gain, for TV (or other mono source) sound for which more gain is provided, for an input from a stereo recorder and also compensation for tape-head output at 7½ i/s. The compensated output from the preamp is available for recording at the output socket; it also passes to the three-contact switching input jack-socket from where it feeds the input to the tone control and filter stages. If a plug is inserted into the input socket, the preamp output is disconnected by the contacts breaking, and the incoming signal is fed into the high impedance (approx. 80K) input to the buffer emitter-follower stage which precedes the tone controls.

The tone controls are the familiar feedback (Baxandall) type, and were derived from a rearrangement of Dinsdale's circuit to use *n-p-n* silicon transistors. The 10K resistor in the bass control circuit is selected on test to give the 'flattest' response with the control at its mechanical (and, one hopes, its electrical) mid point. The ganged potentiometers should ideally be 1dB matched types, but these are expensive and generally difficult to obtain, and in practice 2dB matched types can normally be used without too much variation except at the ends of the tracks. The isolating capacitors used must be good, low-leakage types to avoid crackle or rumble when the controls are operated.

The use of a 'Darlington pair' in the tone control stage is slightly unusual, but was found to contribute the least noise to the system; this stage is operating with a relatively high collector current for the second transistor (to allow for loading in the following controls, and a wide dynamic range) and a single 2N2926 transistor adds just perceptibly to the noise of the system; a single 2N3707 gives a slightly better performance, but the optimum is a Darlington pair using the 2N3707 (low-noise) transistor to feed the 2N2926. Using the pair, the added noise is completely negligible.

The switched feedback filter is adequate

(*continued on page 519*)



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# They told you...

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*Geoffrey Horn*
*—The Gramophone, May 1964.*

*'My comment on this 736HS is to admit that I have squandered the housekeeping money for months to come by investing in it as a reference standard and yardstick against which all future recorders will be judged.'*
*Alec Tutchings*
*—Tape Recorder, May 1967.*

*'In terms of performance, however, it is superior to such an extent that it makes the rest seem toys.'*
*David Kirk*
*—Tape Recorder, May 1967.*

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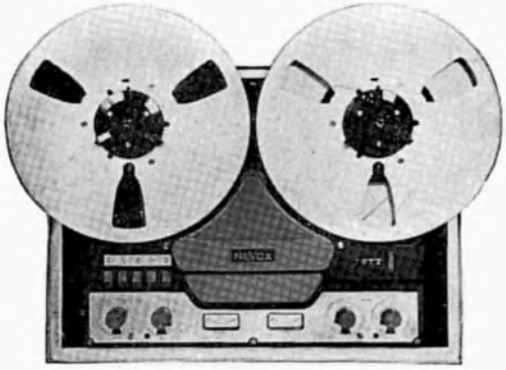

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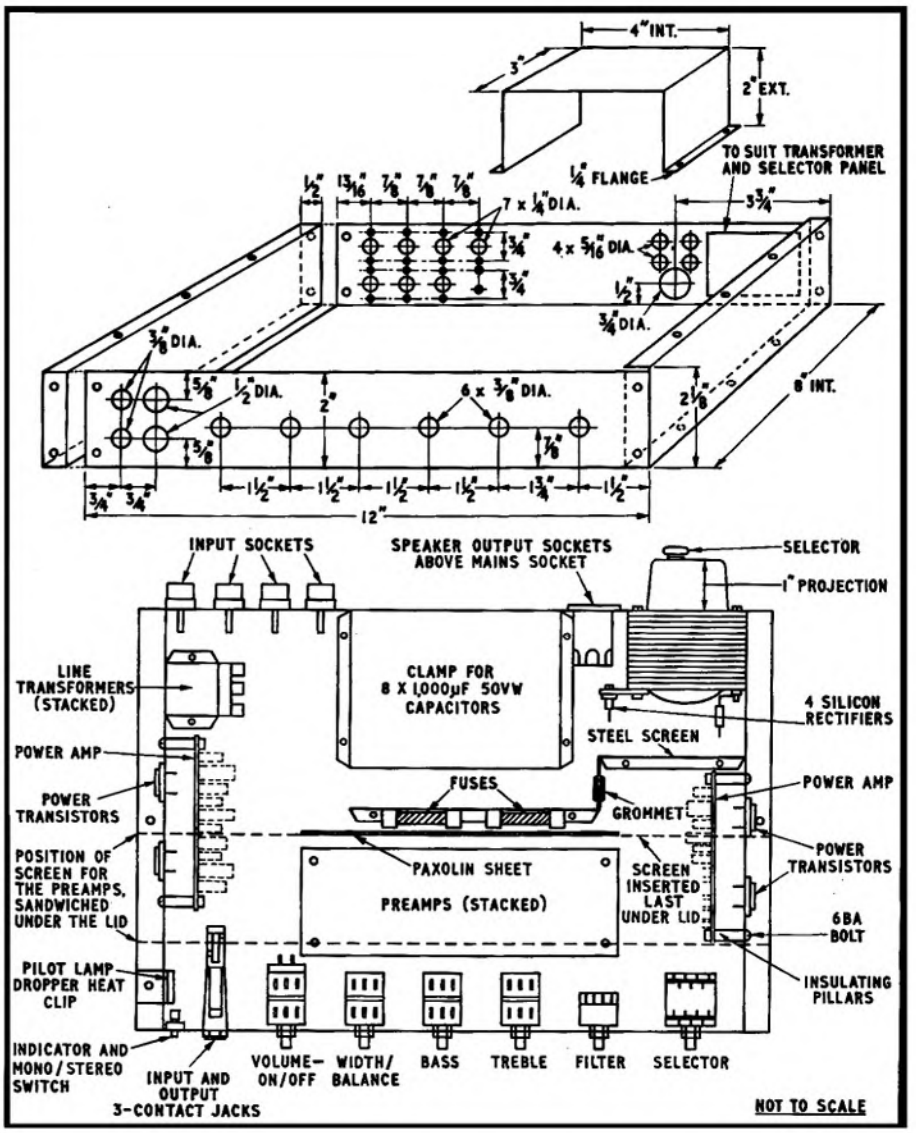
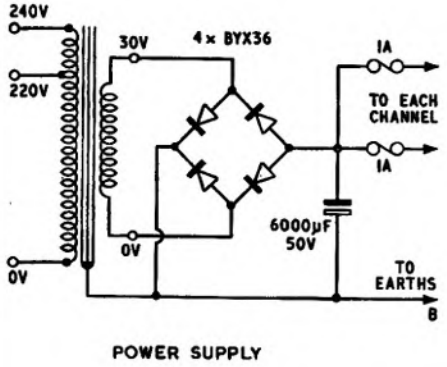
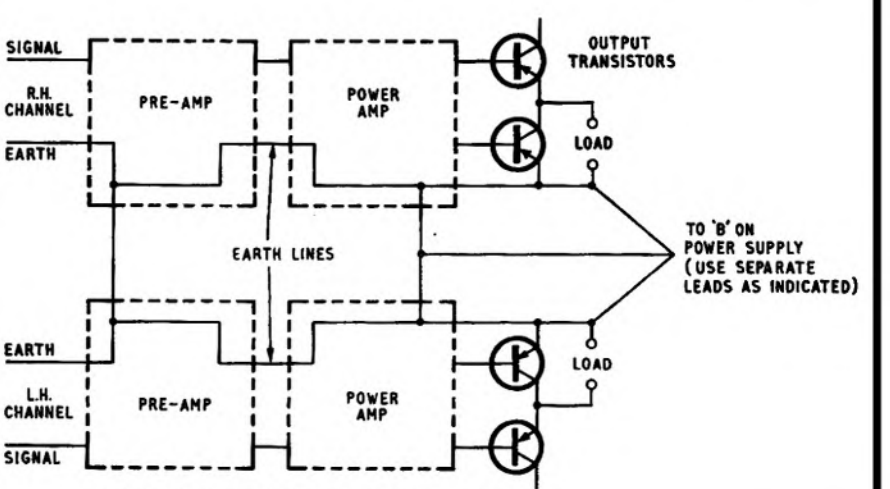
for general listening requirements (although an extra position for a turnover frequency of 8kHz could be useful). The 10kHz position gives a characteristic slight lift below the cut-off frequency, but this is barely noticeable and can easily be compensated with the tone control if desired. Omission of the .001μF capacitor in the 'flat' position gives a slightly improved square-wave response without making any audible difference to programme material, but owing to the high gain of the transistor pair and the high cut-off frequencies of the silicon transistors (of the order of 100 MHz) the stage can give low level oscillation at a high frequency (100kHz or more) if the treble control is wound fully up with the filter in the 'flat' position without this capacitor; this is undesirable because there is a slight risk of damage with some tweeters if the oscillation gets through the power amplifier, and also because of the risk of damage to the power transistors themselves and intermodulation with traces of tape bias getting through. The risk of tape bias going through unattenuated is another good reason to include the .001μF capacitor, as it is quite easy to damage the power or driver transistors, or both, by pick-up of HF bias. This may also be a point to watch with FM multiplex decoders which do not incorporate filters for 19 and 38kHz.

From the tone control stage the signal passes via a 1K resistor to one side of the balance control potentiometer, whose slider is earthed, giving full swing from one channel muted through the normal (central) position to the other channel muted. The control is fairly smooth in operation (except at the extremes of the track, where one or other channel mutes rapidly) giving a slight increase in output from one channel as the output from the other is decreased. Concentric with the balance control potentiometer is the width (or blend)

*(continued on page 521)*

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From Sanyo, a new range of magnificent hi-fidelity equipment that puts your sound in the world class. As an example the MR 999, Sanyo's superb mains stereo/mono tape recorder incorporating two x 6 watt per channel output amplifier, about 105 gns. Speakers extra. Four tracks, three speeds. Sound on sound, sound with sound facilities, automatic shut off. Separate volume control for each channel on record/playback. Some choice features of its specification are given here—but get the full story from your hi-fi dealer. Sanyo also make tape decks, record players, solid state tuner/amplifiers.


*Specification:* Mains Stereo/Mono tape-recorder, using tape deck of above with two x 6 watts per channel output amplifier—extra for speakers. *Tape Speeds:* 7½ ips (19 cm/sec), 3¾ ips (9.5 cm/sec), 1⅞ ips (4.75 cm/sec). *Wow Flutter:* 7½ ips : 0.15% R.M.S., 3¾ ips : 0.20% R.M.S., 1⅞ ips : 0.30% R.M.S. *Frequency Response:* 7½ ips : 30—18,000 c/s 3¾ ips : 30—10,000 c/s, 1⅞ ips : 30—8,000 d/s. ±3 DB. *Output Power:* Maximum : 6W x 2. *Erase Rate:* Less than 65 dB. *Dimensions:* 20″ (W) x 10″ (d) x 16″ (h). *Accessories:* Microphone x 2, recording tape 7″, empty reel 7″, patch cord x 2, reel stopper x 2, splicing tape, speaker lead wire x 2, capstan sleeve, microphone stand x 2.

# SANYO

RELIABILITY IS BUILT IN

control which is used for narrowing the sound-stage or filling the 'hole in the middle' where the speakers in use are rather too far apart for the listening distance or where the recording is gimmicky, with most of the signal coming from the extremes of left and right, and very little from the centre. A linear-track potentiometer was used, matching the track of the balance control, with the control switched out at one extreme; at one extreme of the track the effect is virtually unnoticeable, blending smoothly to mono at the other extreme to parallel the channels when a mono signal is fed to one channel at the auxiliary input jack. As space was limited and a switch on the back of the pot could not be accommodated, one end of the track was given a short 'ramp' of *Araldite*, properly baked and smoothed, on which the wiper sits when the control is required to be inoperative. This has proved quite effective and reliable.

From the junction of these controls the signal passes to the main (logarithmic) volume control. Ideally this should also be a 1dB matched type, but the price and difficulty of obtaining such a pot with a ganged DP mains switch encourages one to settle for a 2dB matched type. These pots have a nasty habit of going noisy anyway, which can get very expensive.

Recapping a little, the input transistors are the not-so-recent low-noise, low current, high frequency silicon n-p-n type 2N930, operated here at a few micro-amps collector current; there are relatively few transistors suitable for use in this manner, at least that are available readily, and they are rather expensive. However it is possible to use the cheap low noise 2N3707 types with quite good results, so long as very high gain specimens are used. The second transistor is being fed from the high output impedance of the first transistor, so to keep its noise to a low level, its collector current must be kept under a milliamp and a low-noise type must be used; in addition, the device must have a high gain as the voltage gain of the pair before feedback must also be high. A *Texas* 2G309 (germanium) is a suitable type for use here as it produces very little noise and has a high gain with a guaranteed minimum. The emitter-follower of the preamp uses one of the cheap but quiet high frequency general purpose 2N2926 types. The buffer emitter-follower for the tone control stage uses another Texas type, a 2N3708, chosen for its high gain and for its higher voltage rating than the 2N2926 which in this position could conceivably be damaged by being driven hard into cut-off as it appears directly across the preamp supply. The transistors in the tone control stage have already been dealt with.

### HEAVY SMOOTHING

Heavy smoothing of the supply to the preamp is provided to eliminate hum caused by supply ripple, a stabilising transistor could of course be used in place of the RC smoothing if required. The base bias for the first transistor of the preamp stage is also decoupled by an 80μF capacitor to prevent LF instability. The 470K resistor in series with the emitter of the first transistor drops the voltage across the transistor contributing to the low noise of this stage, and also limits the LF boost given by the frequency selective feedback in lieu of LF turnover resistors for equalising magnetic pick-ups. The resulting curves are close to the specified RIAA curves using this method which is found in some commercial equipment as well. The transformers used for the floating outputs from the preamps are surplus types (believed to be by STC). They are similar in performance to the miniature *Parmeko* type MSC1829 microphone transformer which could be used with the tapped side as the secondary; with a little ingenuity the slightly larger *Gilson* equivalent type WO2369 could also be used. Performance is very similar to that of the preamp stage alone, the response being only 1dB down on the preamp, when loaded with 600 ohms, at 50Hz.

The power supply is conventional and simple. A small 30V transformer with tapped primary feeds a bridge of silicon rectifiers via a fuse, and smoothing is by the 6000μF capacitor. Each power amplifier is fed separately via a 1A fuse. Mains input is via a miniature *Belling* insulated plug and socket, and thence via a 500mA fuse through screened cable to the mains switch which is ganged to the volume control.

### POWER AMPLIFIERS

The power amplifiers are basically the familiar Tobey and Dinsdale design as described in *Wireless World* November 1961, and January 1965, although some revisions have been made. These differences include the omission of the resistor in the earth line, with separate earthing of the output stages as suggested in the correspondence following the 1965 article, and the inclusion of complementary pair driver transistors utilising a silicon n-p-n transistor, this being less expensive and less sensitive to heating than its germanium equivalent. The transistors used in the power amplifiers were in fact OC44 for the first stage, 2G385 for the second stage, 2G384 and 2N697 for the complementary pair, and matched sets of OC35's for the output transistors. Owing to the greater base-emitter forward voltages of the silicon n-p-n transistors than their germanium counterparts, an additional silicon diode (OA202 or SX11) was placed in series with the OA5 diode in the bias stabilising circuits of the drivers. Small series resistors were used in addition, to provide a quiescent current of 25-30mA in the output transistors, slightly higher than in the original design but preferable to too small a standing current, the constructor may use a preset. Clip-on heat-sinks were used on the driver transistors as a precaution against overheating, while the output transistors were bolted, with mica washers and insulating bushes, to the recessed ends of the main chassis which act as heat sinks. The printed circuits carrying the power amplifier circuitry are bolted, with insulating pillars, to the same end pillars, so that the whole power section of either channel can be hinged out on its wiring for servicing. The output isolating capacitors are clamped in with the power supply capacitors at the middle of the back of the chassis. The emitter resistors of the output transistors are mounted between tags and the transistor pins, and the stabilising diodes are fixed to the heat sinks close to the power transistors with a smear of Araldite.

Heavy gauge wiring was provided for the negative supply and output leads, and particularly heavy wiring was used for the positive (earth) wires to minimise trouble from asymmetrical pulses in the earth line.

A preset resistor was included in the biasing of the first transistor of the power amplifiers to adjust the 'sitting point' of the output; the collector of the lower power transistor should sit at about half the supply voltage under no-drive conditions. The output to the loudspeakers is taken via wander sockets; 470 ohm resistors between the output capacitor and earth (on each channel) prevent damage to speakers (or ears !) if the speakers are plugged in after switching on: normally there is a plop and short hum on switching on, which is not serious.

The indicator bulb is a 15V *Lilliput* low current type fed through a 1.5K resistor (in a heat clip fastened to the chassis) from the main negative supply. The bulb itself projects through a grommet in the front panel, with no bezel, and glows brightly without being distracting.

The main chassis is made of 16 SWG aluminium, as are the recessed end panels which act as the heat sinks. The cover panel is made of 18 SWG aluminium. The internal screens are made of 20 SWG mild steel. The clamp for the large electrolytic capacitors can be 18 SWG aluminium or 20 SWG steel, and the clamp for the line output transformers is conveniently made of 18 SWG aluminium strip as well. All dimensions are as given in the diagram. The various pieces of metalwork are bolted together with countersunk ¼in. 6BA bolts. The front panel is made of black laminated plastic, varnished over to protect the lettering, secured to the main chassis by the lock-nuts on the controls and jack sockets.

### SOME MONTHS

The performance of the integrated amplifiers, in use now for some months, is felt to be very satisfactory. All said and done, it is how an amplifier sounds and how useful it is, that are the important things in a design like this, which is intended to be a simple and practical piece of equipment. The results are pleasing, and after initial adjustments the amplifier has been in regular use for listening to discs—via a *Shure M44-5* pickup, *Decca* arm and *Garrard* 301 turntable—to *FM* tuner (including, experimentally, BBC stereo transmission) and of course to tape recordings, all normally fed to *Goodmans Maxims*.

The subjective noise performance of the preamps is very good, the hiss level comparing very favourably with many established commercial designs; the hum performance can also be very good, but because the various units are so close together great care must be taken with screening to keep hum down, and the steel screens should not be omitted. The cans of the smoothing capacitors appear to radiate an appreciable hum field which requires the double screening between them and the preamps. The pickup and tape inputs should be sited furthest from the capacitor bank to minimise hum pick-up there, and it is important that all wiring carrying low-level signals should be screened. Pro-

(*continued on page 525*)

ALTHOUGH helical-scan video tape recording has suddenly become really big business (Ampex alone have more than a thousand of these machines in service), transverse-scan continues to improve and to astonish.

As long as ten years ago both RCA and Ampex in America marketed successful transverse-scan (RCA call theirs *Quadruplex*) studio-operation VTRs for monochrome and colour, with both machines using more-or-less the same basic system for recording the very high frequency television signals.

To recap, the Ampex *VR-1000* used a rotating disc with four magnetic heads mounted at the outer circumference, with the head-gaps parallel to the disc axis. The signal was recorded vertically rather than horizontally, resulting in a series of 120° arc traces across the 2 in. tape. Using a tape speed of 15 i/s and a 2 in. diameter disc with a rotational rate of about 240 r.p.s., the head-to-tape writing speed was in the order of 1500 i/s. This permitted a high frequency response of up to 4MHz.

The 120° arc was transcribed during the complete sweep of one head across the tape. With the four heads performing 960 transverse sweeps for each second or 15 in. of tape, one frame occupied one half-inch longitudinally in 32 successive sweeps, each track carrying 16 or 17 horizontal lines of video information.

The tape carried three other synchronised tracks: the normal *sound* track accompanying the picture; the *control* track comprising a record of the alternating currents feeding the disc-motor during the recording, and acting as a reference point for editing; and the *cueing* track. The cueing track being used by the producer to indicate points at which he required the various camera positions to be edited in.

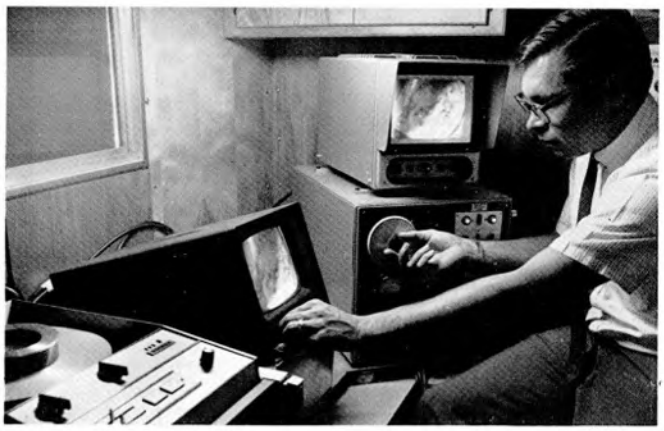
Guiding of the tape past the rotating disc was accurately, yet delicately, controlled by a concave guide which was used to cup the tape round the disc. The relation of tape to rotating heads had to be intimate and good head contact at constant pressure was required. This was accomplished by maintaining the fit of the concave guide within small tolerances to the exact path of the rotating heads and through use of vacuum applied from the guide side of the tape. The air-pump attached to the guide extracted air from the chamber formed by the metal guide and the uncoated surface of the tape, providing a highly efficient wrapping system.

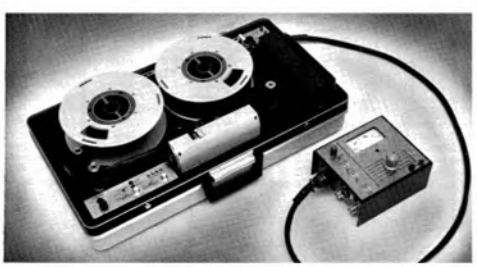
A pulse superimposed over the control track at the bottom of the tape marked the blanking time between television fields. By cutting and splicing together the tape during this vertical blanking time the television picture did not lose sync and so cause picture roll. To enable operators to insert commercials quickly into programmes within the split-second timing requirements of station breaks, Ampex further developed a liquid solution to make the impulses visible to the eye. This was called *Edivue* and was a suspension of carbonyl iron which was applied to the oxide side of the tape. While in the solution, the iron particles arranged themselves on tape in much the same way that iron filings form a pattern on a sheet of paper laid over a magnet.

The next development was a semi-automatic splicer with but a short step to the Ampex *Electronic Editor, Mk. I* and *Mk. II* for the VR-1000 and the *VR-1100* series and *Mk. III* for the *VR-2000* series. The VR-1100 and the VR-2000 were later developments of the VR-1000 but retain the basic principle of transverse-scan.

In 1964, the VR-2000 gave a totally new standard of performance to Ampex VTRs by employing the 'high-band' concept. With high-band, carrier and deviation are moved up in frequency to provide a wider guard-band, more room for colour, and greatly reduced moiré interference effects. After this came the compact and highly mobile *VR-1200* with solid-state electronics and a high-band performance in monochrome and colour and which was instantly switchable to low-band as well. Furthermore, as many stations were working with the older type machines (and still are), it was designed to be fully compatible with all models.

The very latest Ampex—the *VR-3000*—is a remarkable little transverse-scan machine. It weighs only 40lb. and can be carried on the camera operator's back in an alpine carrying rack. It can be operated either by a silver-cadmium battery or from AC power





**Upper left:** Ampex video recorder and monitoring equipment attached to the borehole television camera **(middle left)** being employed by the Department of Water Resources in California.
**Bottom left:** Ampex battery VTR with cover removed.
**Top right:** Complete Ampex Back-Pack system.
**Lower right:** Camera and microphone components of the Sony battery VTR
(see page 503).

# CLOSED CIRCUIT

## NO 2 VIDEO OUT OF DOORS

BY RICHARD GOLDING

lines. With a tape speed of 15 i/s and 8in. reels it has a recording time of 20 minutes. It is instantly switchable between high-band/low-band monochrome and high-band NTSC/PAL/SECAM colour, and the recorded tapes are instantly playable on studio VTRs. The 'back-pack', as it is called, is used in conjunction with the VR-3000 hand-held Plumbicon tube camera, which weighs only 12lb. The system is stated to operate easily and reliably under very difficult field conditions. Many normal VTR adjustments have been eliminated, automated, or incorporated in the camera's electronic viewfinder. For example, combined record/servo-lock/tally light, video-level indication and recording-elapsed-time present a single viewfinder display; excessive white peaks are inverted to black, allowing cameramen to make a correct aperture setting. The camera's high sensitivity produces excellent pictures with light levels as low as 30 foot-candles. The price, however, when it is introduced to the British market shortly, is likely to be in excess of £20,000.

Studio operation transverse-scan equipment is very expensive and, together with other manufacturers, Ampex realised that in order to satisfy the requirements of CCTV applications in such fields as education, industry, medicine and sport a much cheaper system had to be evolved. Thus in 1963 the helical-scan principle was developed, allowing the use of slower speeds and narrower tapes.

The latest Ampex helical-scan VTR, the *VR-7003*, offers a maximum recording time of 60 minutes using a 3,000ft. length of 1in. Ampex 147 tape on a 9¾in. reel. To obtain the necessary high writing speed the video head is set in a drum and rotated at 3,000 r.p.m. The tape is wrapped around the drum in approximately a 3° helix angle and moved longitudinally at a speed of 9.4 i/s. This tape movement and head rotation gives a writing speed of about 833 i/s. In addition, the video information is processed with electronics to an FM signal for ease in recording. Two audio tracks are recorded on the lower edge of the tape, and a control signal is recorded on the upper edge of the tape to assure proper positioning of the video head during playback. A bandwidth of 3.5MHz is recorded with a signal-to-noise ratio of 40dB and a horizontal resolution of 300 lines. Guaranteed head life is 500 hours with a routine adjustment after 250 hours. The VR-7003 weighs 100lb. and the price is just less than £1,500.

The Ampex *Videotrainer* is a CCTV unit which uses the VR-7003 in a mobile console. It includes a television tuner, picture monitor, audio amplifier and speaker, cardioid microphone with floor stand, a vidicon camera with 12.5mm., 25mm. and 50mm. *f*/1.4 lenses, tripod with tilt head and all necessary switching facilities and cables. It weighs 360lb. and is priced at just less than £3,000.

The control track on both these models consists of a series of uniformly-spaced pulses. When editing, if it is necessary to obtain an instantaneous transition from one scene to another, the splice must be made parallel to the diagonal video tracks which are 16.6in. in length, and the two pieces of tape must be placed together so that the control track pulse position error does not exceed 0.01in. across the splice. To make the magnetic tracks visible, Edivue can be used. It can be seen, however, that because of the length of the splice, this diagonal joining is no simple matter.

A fairly smooth transition between scenes can be made by a simple 90° splice across the tape if the tape is so positioned that the control track pulse rate is not disturbed by the splice. In this case the information of the new scene will first appear at the top of the monitor screen and then sweep downward, replacing the old scene. The transition time is 1¾ seconds. In making the splice, Edivue should be used to identify the position of the control track pulses. Several tape splicers are available and ½in. wide, 0.5 thou aluminised splicing tape should be used. Splicing tape thicker than .003 in. may not be used.

The Subsurface Exploration Branch (Geophysical Section) of the California Department of Water Resources has added a *VR-7000* (forerunner of the *VR-7003*) recording to its reports on subsurface conditions at sites of proposed dams, highways and related structures.

"In typical operation, we lower the special borehole television camera into a prepared drill hole", explained head technician Darrell Perkins. "The camera transmits an image of the rock or soil in the borehole to a television monitor above ground. Previously we prepared our reports based on, among other factors, the television picture we saw on the monitor during exploration. But now we can record these pictures on videotape, replay them as part of our report, and store them to give the engineers and geologists another look at the subsurface conditions at some later date."

Although the primary activities of the Subsurface Exploration Branch are drilling and geophysics, television inspection of boreholes as deep as 1,300ft. represents a significant additional service.

Perkins cited a recent example of giving contractors vital information by videotape. "Near Livermore, California, where the Del Valle Dam is now under construction, there is a vertical shaft which was dug in 1934," he said. "The shaft is an entrance to the Hetchy-Hetchy aqueduct tunnel which runs through the Coast Range of Northern California. The shaft will have to be earth-filled because it is located within the planned Del Valle reservoir, and will be inundated by the reservoir if left as it is."

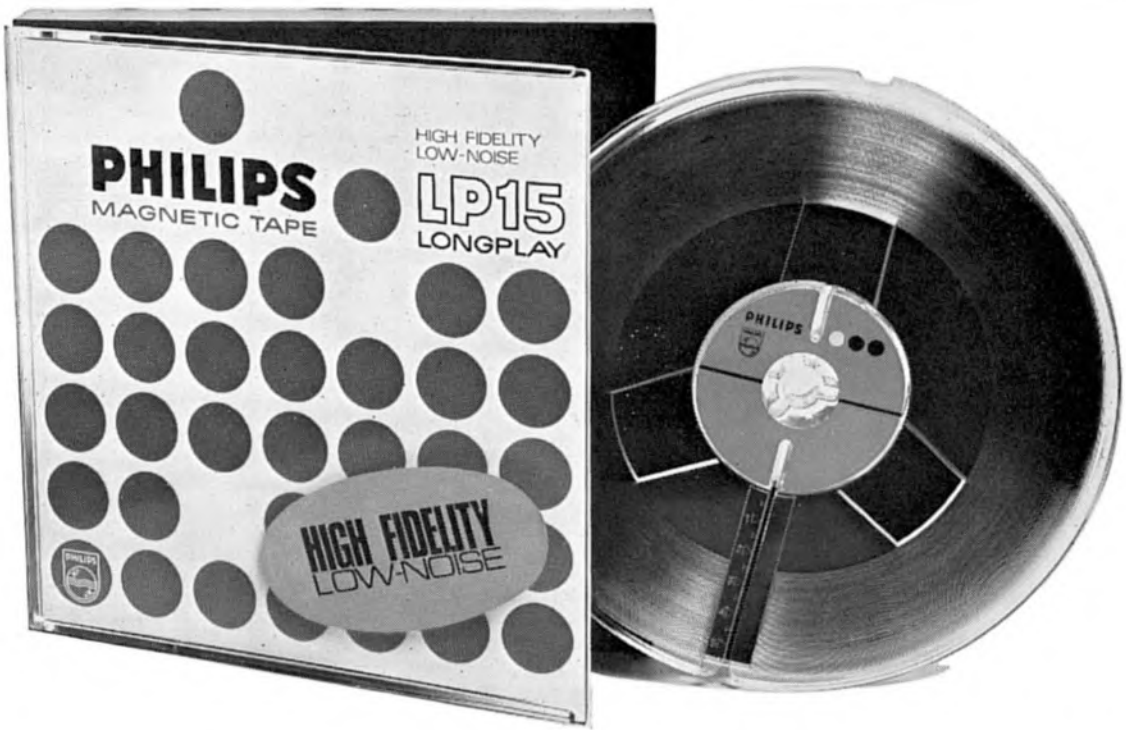
When the engineers approach the earth-fill job next year they will need, without delay, complete information on the shaft's condition. Perkins has already explored the shaft by lowering with cables the television camera which is glass-enclosed in the middle of a steel cylinder two inches in diameter and six feet in length. The camera sees out to the walls of the borehole through a mirror which can rotate 360°.

"We recorded important portions of the shaft views on videotape," Perkins said. "Instead of the usual still photographs taken of the image on the monitor, the visual information will come from a videotape recording." The recording, played back on the portable Ampex machine through an 825 line monitor, will show engineers the shaft as though they were watching a live telecast of the 400ft. deep interior.

Perkins has also completed a videotape exploration of boreholes at a proposed highway relocation route near Yreka in Northern California, using the department's trailer-mounted power generating unit. The full system includes the television borehole telescope, made by *Eastman International* of Hanover, West Germany; the Ampex VR-7000; and the 9-inch *Conrac* monitor.

The problem of presenting thorough reports on certain subsurface compositions of rock and soil continues to be a challenge, but helical-scan videotape replay is doing much to minimise this.

# Philips announce High Fidelity low noise tape ...at no extra cost!




**Background noise virtually eliminated**
Up to now, tape recorders have been capable of better-quality sound than conventional tapes could handle. The problem has been background noise, which kills the effect of soft passages of music and is particularly irritating when volume is turned up. Now Philips have found the answer: High-Fidelity Low-Noise Tape, giving a remarkably low noise level, as much as 4dB (decibels) better! With this tape, background noise is undetectable under normal listening conditions. The secret lies in the discovery of a new magnetic oxide, developed in Philips Research Laboratories where Philips spend £60 million a year on research and development. No matter how you play your recordings back, they will be noticeably more clear and brilliant with this new tape. Price? Same as old fashioned tape!

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Philips High-Fidelity Low-Noise Tape comes in a handsome new reel of totally new design. It protects better, looks great!

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Everlasting dust-sealed packs with transparent lids have labels which, reversed, become index cards. Packs stand in smart clip-together racks so that you can easily build your own Sound Library—*free!*

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# a christmas carol

A SEASONAL NONSENSE FOR AUDIO DRAMATISTS BY DAVID HAINES

ANNOUNCER : This short play is entitled *A Christmas Carol.*

HUSBAND : Everything is prepared. Switch off the light !

WIFE : Yes, dear. (*click*) Now what ?

HUSBAND : We both sit on the sofa—in the dark.

WIFE : Can't we have the television on ?

HUSBAND : Certainly not ! We must both sit absolutely still—and we mustn't make the slightest noise.

WIFE : Do you think this plan of yours is really going to work ?

HUSBAND : Of course ! By the way, did you switch off *all* the lights upstairs ?

WIFE : Yes. The whole house is now in total darkness.

HUSBAND : Splendid ! From the road, the house will seem utterly deserted.

WIFE : What happens now ?

HUSBAND : We wait.

WIFE : For how long ?

HUSBAND : They'll be banging at the front door any minute.

WIFE : And then what happens ?

HUSBAND : I've already explained the plan —and I've made it quite clear. It's a very simple but effective way of dealing with carol-singers. We simply sit tight and pretend we're not at home.

WIFE : With what result ?

HUSBAND : Isn't it obvious ? They'll stop singing and they'll clear off !

WIFE : It would be much simpler to pay them. You can't fool a veteran carol-singer.

HUSBAND : I don't agree. Anyway, we're *not* going to answer the door.

(*Carol-singing begins from outside the house. After a few moments, carol stops abruptly. Door hammered briefly. Carol then resumes behind the dialogue.*)

WIFE : Must we sit in the dark ? Surely we can have the light on—in this one room ?

HUSBAND : We daren't risk it. They might see through a chink in the curtains. It's the sort of thing they look for.

WIFE : Can we have some coal on the fire ? It's nearly out.

HUSBAND : I'm very sorry, but there's no more coal in the bucket.

WIFE : Can't you creep outside to the shed and get some ?

HUSBAND : It would give the game away. There's nothing so noisy as the shovelling of coal.

(*His wife softly begins to join in the carol.*)

HUSBAND : Are you mad ?

WIFE : (*breaking off carol*) I've got to keep warm somehow. Or shall I do some silent physical exercises ?

HUSBAND : Sit still and keep your voice down. (*kindly*) I'll get you a tot of rum from the sideboard . . . (*after a pause*) Here you are—and don't let your teeth chatter on the glass.

(*Carol stops abruptly. Door banged with vigour. Carol doggedly resumes.*)

WIFE : They don't seem very discouraged.

HUSBAND : Oh, they'll soon realize we aren't here.

WIFE : But we *are* here.

HUSBAND : I know we are—and that's why we mustn't make any noise or show any lights ! (*after a pause*) They sound exactly like the carol-singers we had last night.

WIFE : You should have paid them—then they wouldn't have come back.

HUSBAND : (*indignantly*) I gave them a lot of money—more than they deserved !

WIFE : (*soothingly*) I know you did. But they want English money.

HUSBAND : Those French coins were probably very valuable.

(*Carol stops abruptly. Door hammered and kicked with even greater vigour. Carol resumes with grim determination.*)

WIFE : You'd better think of another plan. Try scaring them off with one of your imitations. Open the window and snarl like a Siberian wolf.

HUSBAND : Your suggestion is ludicrous. I can only imitate animals of a relatively harmless disposition —as you know perfectly well !

WIFE : But certain farmyard animals can be quite fierce—a goat, for instance, can be very formidable when suitably stirred up.

HUSBAND : I refuse to render the impression of a stirred up goat. I haven't had sufficient practice.

WIFE : Open the window and try !

HUSBAND : It wouldn't be appropriate. For what conceivable reason would a goat be living in the front room of a semi-detached suburban residence ?

(*Carol stops abruptly. Door assaulted with violence. Carol resumes—and wife joins in with gusto.*)

HUSBAND : (*in disgust*) This is too much —I give up ! Go and open the front door—and give the little devils a blank cheque.

(*Door knocking and carol-singing swell into pandemonium. Fade out.*)

---

**THE PINT POT** CONTINUED

viding precautions are taken, hum should not be troublesome. The noise contributed by the tone controls and the input stages of the power amplifiers is quite negligible.

Distortion at normal listening levels is not apparent—at least not on programme material, where it would normally anyway be exceeded by distortion in other links in the chain. The preamp overload performance is excellent, it will accept a level of at least 23dB above the minimum for full output without serious distortion of the waveform. The amplifier has not been rigorously tested under full power sinewave drive conditions to avoid possible overheating and damage, but the small size of the mains transformer limits the continuous power to about 7W per channel at mid and low frequencies, falling at high frequencies. However on short peaks full power is available, and at low power (normal average listening levels) the output is consistent over the audio range. The equalisation for LPs and 78s is very close to the specified RIAA curves, and approximate equalisation for tape heads at a tape speed of 7½ i/s is provided, correction for HF losses and adjustment of the bass must be made with the tone controls.

The tone controls provide (*bass*) a maximum boost of 12dB at 50Hz and maximum cut of 15dB at the same frequency, and (*treble*) maximum boost of 15dB at 20kHz with maximum cut of 13dB. The slight low frequency bump with the bass control level and the slight shift of mid frequencies with operation

(*continued on page 546*)


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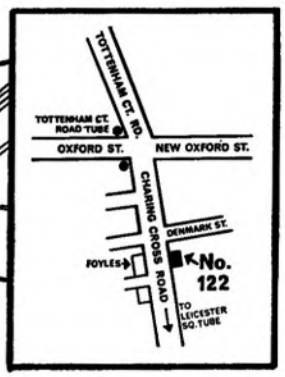


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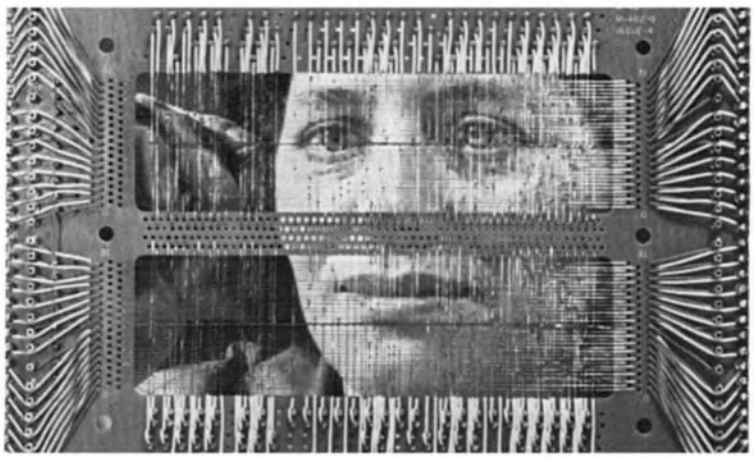

# YOUR OBEDIENT SERVANT

PART FOUR THE CORE MEMORY BY H. W. HELLYER

THE computer depends upon storage devices for its speed and range of operation. As the whole idea of the computer is that it will perform tasks of calculation at tremendous speed, all the data that provides the basic reference for the programme with which we feed the monster has to be retained in some form that allows us to trigger off the switching circuits and select this reference automatically. When talking about Boolean algebra, we mentioned the elementary type of store, such as the flip-flop device, which gives out one type of pulse when triggered by another. By building up banks, or blocks of such circuits, set to a particular mode, then applying our triggering pulse, we obtain an output of information depending on the setting of the switchbanks. But this is only one very simple type of selection, and in practice we find that quite sophisticated storage devices are necessary, because the human operator could not tell the computer what he wants it to do quickly enough by simply switching and triggering.

For this reason, we find the store and its register form a basic combination. In programming language, a 'loop' is formed, whereby the register acts as a temporary store. Data that is going to be used in a particular application is continually modified as the computing operation proceeds, and then added to the main memory store—a parallel being the assessment of the world around us by our senses, in a continual process, the vital factors then being committed, albeit unconsciously, to our memory. Our conscious mind acts as the register and our sub-conscious, the main memory store. Racking our brains for an answer to a problem is a form of 'read-off' while correlation of data when we weigh up our problem or decide on the course of action, is in some ways akin to the 'arithmetic unit' that also forms part of the basic loop.

Babbage, when he bent his considerable brain to the problem of making a calculating machine, had three main sections: the mill (equivalent to the arithmetic unit), the store of punched cards, and the control which was the operator's selector device. The mill was a collection of toothed wheels that actually carried through the adding and subtracting task. It was only the limiting factor of mechanical operation that made the original analytical engine, abandoned in 1842, less efficient than today's electronic marvels. And one of the principal reasons for our modern advance is the development of the memory store.

## VARIOUS STORES

In Part 2 of this series we touched upon the various types of store, and mentioned the magnetic core memory. This is only one type of memory store: such previous devices as acoustic delay lines of memory, nickel or quartz, cathode ray tubes (Williams tubes), and magnetic drum memories, or present devices which also use magnetic drum, disc or tape, also claim our attention. But the ferrite core is a fascinating aspect of computer technology that remains within our brief of 'the magnetic medium' and may help us understand a bit more about the modern electronic machine.

First, why ferrite? Why not steel, which is easily machined and has good magnetic properties?

The answer lies in **fig. 1,** which compares the hysteresis loop of ordinary steel, at (a) with the 'square' loop of ferrite at (b). From previous dissertations on heads, high frequency bias and the general subject of tape recording, most of us will be familiar with the symmetrical but non-linear curve of (a). We remember that the axes of this graph are horizontal **H**=intensity of applied field and vertical **B**=density of the flux in the magnetised material. We need not bother about units for this quick glance at comparative loops, but need to recall that positive and negative signs indicate opposite direction of the inducing current and polarity of the flux respectively. Starting at **O** for a demagnetised piece of iron or steel, we increase our magnetising current positively towards BM and note that the flux increases at first rapidly then less so as the material nears saturation. At this point, **A** on the curve, we reverse the direction of the current and the flux density begins to fall. But when magnetising current is zero, there is still a considerable flux density at **B** and this is the measure of the residual magnetism of the material.

As a matter of interest, this smoothly drawn curve is deceptive; changes in flux density proceed in a series of small steps. These can actually be heard as clicks in earphones if a specimen is coupled to a secondary loop and the output amplified—one illustration of the well-known Barkhausen effect which causes one of the problems for designers of television line output stages.

## NEGATIVE DIRECTION

The remainder of the hysteresis loop of (a) needs little explanation. Continued application of field in the negative direction further reduces the flux density to **C** and then increases it in opposite polarity to saturation at **D,** when reversal of current causes a reversal of the curve via **E** to **F,** never returning to **O** unless the material is demagnetised again. The field intensity between **C** and **O** is a measure of the coercive force required for that particular specimen.

As another matter of interest—and to forestall the purist who will jump on me for the statement 'never returning . . . etc' in the foregoing paragraph, let me hasten to qualify. Although the flux density has dropped to zero when the field intensity is negative at **C** (or again, positive at **F**), removal of the field at this point would not leave the specimen in a demagnetised condition. In the finite time of the collapse of the field, magnetisation would continue, leaving negative or positive residual magnetism (opposite polarity in this context). This is one reason why we remove a demagnetiser slowly from the heads before switching off, and why designers incorporate delay circuits in oscillator stages to provide decremental decay of the magnetising force.

Another point that should be mentioned here is that the **B-H** curve is actually a major loop, representing the greatest field and flux measurements for the given material. Each specimen will actually have several related minor loops, and it is often one of these minor loops that is employed by the ferrite core. This is to help discriminate against currents smaller than those used for switching, for reasons that will become clear as we progress.

Following from this, we take a look at the 'square' loop of the ferrite material in **fig. 1b.** Not really square, of course: no material is ideal, whatever the copywriters say! But the residual magnetism is very nearly equal to the maximum magnetisation. In other words, the two residual states of the material contain much more flux than iron or steel could under similar conditions. This allows a higher amplitude read-out signal and better signal-to-noise ratio, as well as the aforesaid discrimination against smaller currents. Two of these smaller currents provide a magnetising force as shown at **H/2** positive and negative and are known as half-select currents. Remembering that the core is used in a binary system, either in a ONE state or a ZERO state, we see that **H/2**

*(continued on page 529)*

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| Elizabethan LZ34 ... | 8 18 6 | 2 4 8 | 34 |
| Ferguson 3218 ... ... | 8 18 6 | 2 4 8 | 34 |
| Telefunken 201 ... | 8 18 6 | 2 4 8 | 34 |
| Ferguson 3222 ... ... | 9 3 9 | 2 6 0 | 35 |
| Philips EL4305 ... ... | 9 9 0 | 2 7 3 | 36 |
| Grundig TK140 ... | 10 2 2 | 2 10 7 | 38½ |
| Philips EL4306 ... ... | 11 0 6 | 2 15 2 | 42 |
| Ferguson 3214 ... ... | 11 11 0 | 2 17 9 | 44 |
| Truvox 44 ... ... | 12 6 9 | 3 1 9 | 47 |
| Ferguson 3216 ... ... | 12 17 3 | 3 3 4 | 49 |
| Tandberg 843 ... ... | 15 9 9 | 3 17 6 | 59 |
| Philips EL3556 ... ... | 16 5 6 | 4 1 5 | 62 |
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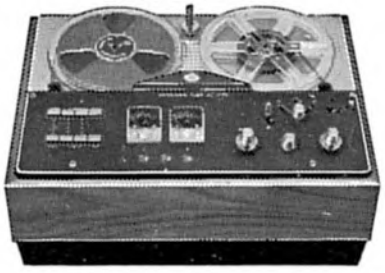

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| Telefunken 301 4-T ... | 14 3 6 | 3 10 11 | 54 |
| Telefunken 302 4-T ... | 15 9 9 | 3 17 6 | 59 |
| Grundig TK6L ... ... | 17 6 6 | 4 6 8 | 66 |
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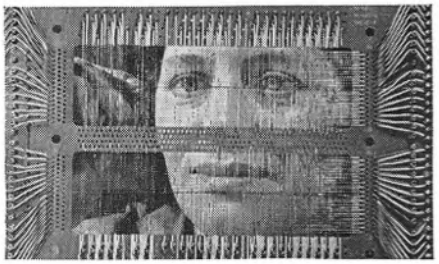


is not sufficient to switch the core to ONE, or to ZERO if the core is in either state, but a combination of two such currents in the same direction will do so. Point B on the curve represents the ONE state and point E the ZERO state. The core in practice receives five kinds of impulse—considering no input as one impulse, then **—H, —H/2, +H/2** and **+H**.

In the specimen we are considering, with a nearly square hysteresis loop, the squareness ratio, density/intensity, is a measure of the quality of the core. Modern ferrites approach very near unity, and once magnetised in one direction will stay that way until magnetised in the opposite direction.

The cores may be quite small, about a fiftieth of an inch in outside diameter, and thousands of them are stored in a matrix made up of current-carrying wires, taking up only a few cubic feet of space. They are similar, in some respects, to the anti-parasitic beads that we commonly find employed as small inductors in modern radio and television receivers. The material is a compound of iron ore and ferrite in a ceramic-type form, cut to a toroid. The basic ingredient may be iron ore hematite, ($FE_2O_3$), which may be blended with FeO to form iron ferrite ($Fe_3O_4$), with NiO to form nickel ferrite ($NiFe_2O_4$) or with MnO to form manganese ferrite ($MnFe_2O_4$).

The reason for the cagey use of "may be" in the foregoing sentence is that the makers are as jealous of their private compounds as any cosmetic manufacturer. They mix and bind them, fire them in kilns and cool them in carefully controlled processes like present-day alchemists—and produce results even more wonderful than any sorcerers. Consider, for example, the switching time of as little as 0.17μS of a modern matrix. This time is dependent upon size of core, quality ratio and type of material. The time cycle includes read-out and write-back periods plus a small before-and-after limit for the decay of transient phenomena made necessary by the external circuitry as much as anything else. A decade ago, the cores had an external diameter of 0.08in. or about 2mm., and cycle of switching times was about ten microseconds.

How is the switching done in the matrix? Obviously, with core sizes so small, we cannot have masses of wires floating about. One system widely used, and originally developed by the Massachusetts Institute of Technology, is the four-wire coincident current core store. Reducing it to its fundamentals and taking a specimen corner of a matrix with nine cores as an example, we get something like **fig. 2.** Each core has four wires threaded through it, but only one is common to all cores. The vertical and horizontal drive wires are **A, B** and **C** (with **a, b** and **c** switched in conjunction),

*(continued on page 531)*

FIG. 1

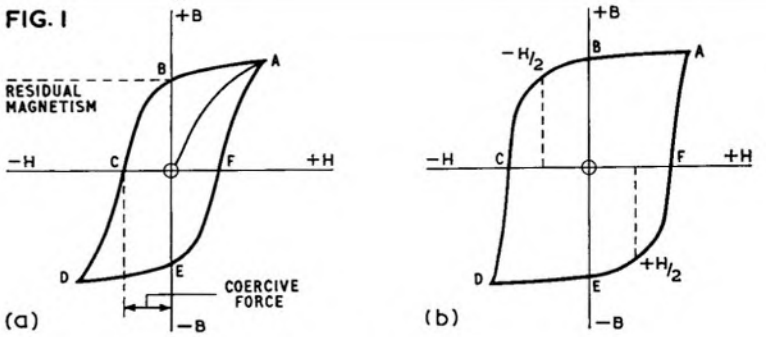



FIG. 2

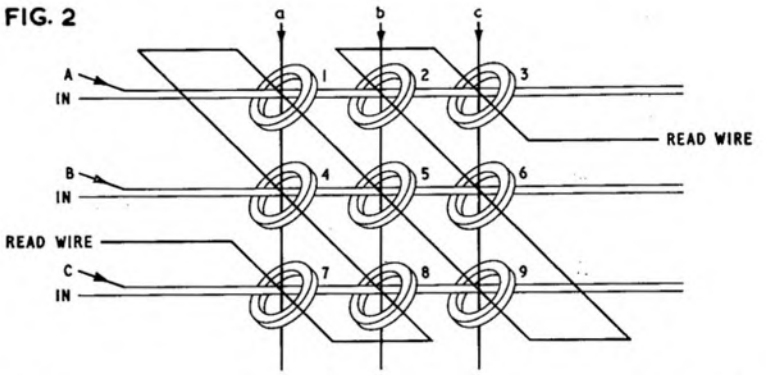



FIG. 3

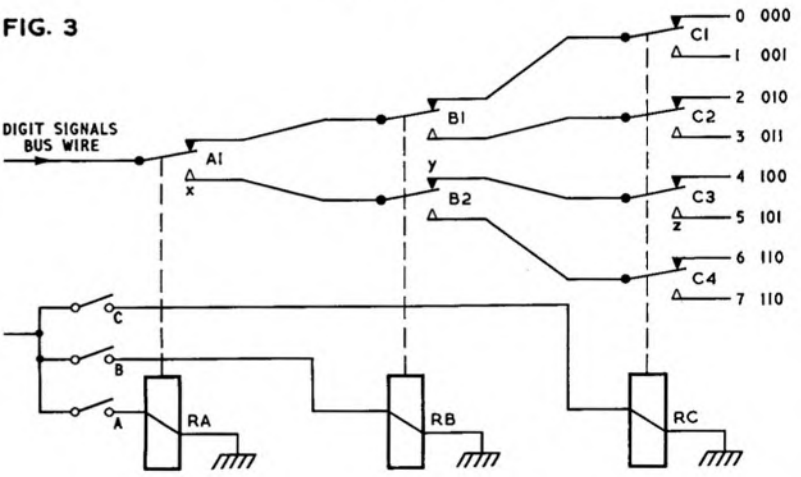
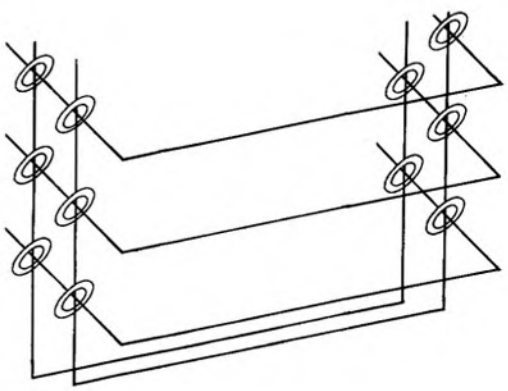



FIG. 4



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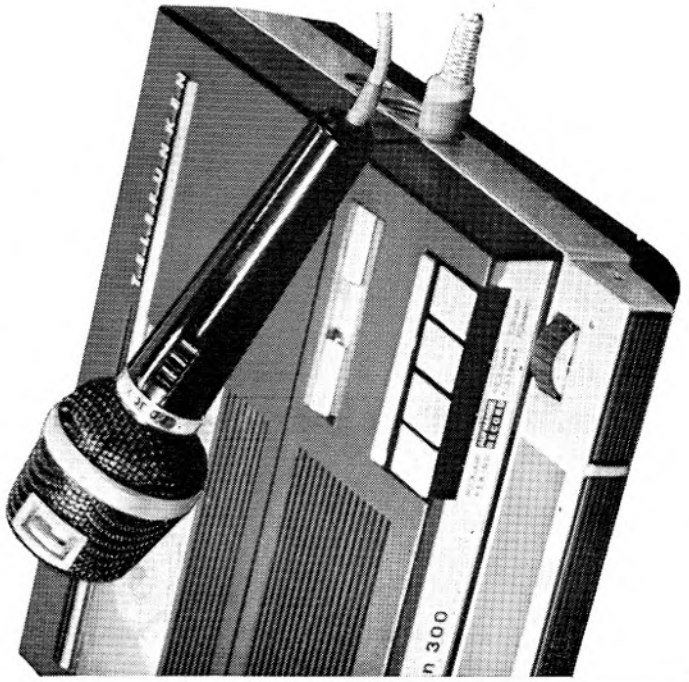


530

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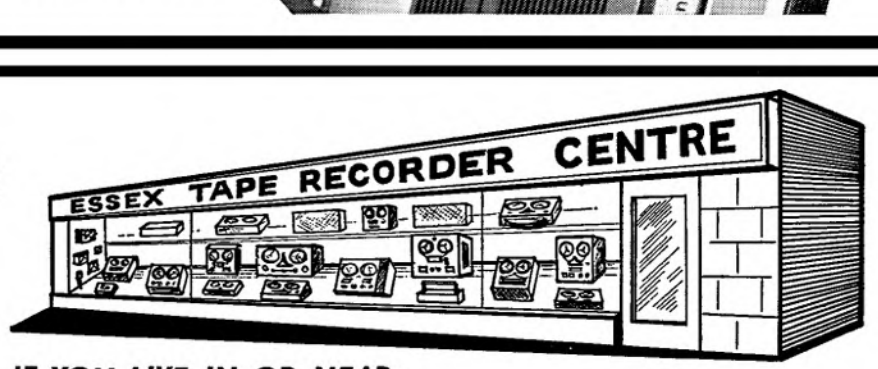


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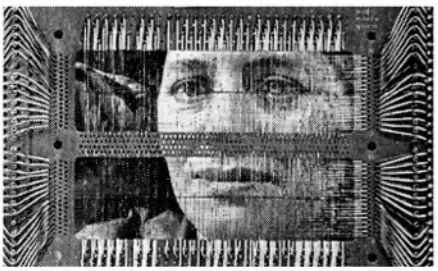


arranged so that half-select current along one plane combined with half-select current in the other will magnetise the core at which the planes cross. Thus **A+a** energises core **1** and **B+b** addresses core **5, C+c** addressing core **9.** This switches the addressed core from state Zero to state One.

But along each horizontal plane we have an 'Inhibit' or writing wire and a similar current (i.e. half-select) in the opposite direction will prevent a core from magnetising by cancelling one half of the magnetising force in that core. So we select which cores we want at 1 by addressing them and those we want at 0 by inhibiting. The inhibiting current through the other cores has no switching effect.

To read out from the store, we reverse the current in the drive wires. Any core that was at 1 reverts to 0, but those at 0 remain at 0. Magnetic disturbance from the switching cores registers on the read-out wire and is passed to the necessary circuits. The next switching operation is to feed back to the memory store the information we have just taken out, so that it is ready for future access, and this needs additional switching.

Although this external switching is electronic, it is convenient to study the method by looking at the arrangement of relays that can do the same job. **Fig. 3** shows a 'relay tree' where three relays select up to seven store places, each binary digit operating a relay. Suppose we want to select 5: this is 101 in binary code and so relays **A** and **C** are closed. The input wire is routed via switch positions **x, y** and **z** to the appropriate position. With no relay closed, the input wire selects 0. The relay was used as the bistable element, selecting 0 or 1, in many of the earlier computers, but even with modern reed devices, and other magnetic relays, the time factor is limiting, and electronic switching is more usual in current equipment.

### WORDS NEEDED

So far, we have been considering individual cores, and single planes in a matrix. But in practice, words rather than bits are needed. Groups of bistable elements form words. Grouping of words into planes reduces the number of wires in a matrix and quite complicated arrangements can result. A simple development of a two-plane grouping of two-bit words, reducing the drive wires from eight to six is shown in **fig. 4.**

Ferrite cores are temperature sensitive, the shape of the hysteresis curve changing as the applied heat changes. Computers are designed to operate at 'normal' room temperatures of 70 to 80°F, and air conditioning is generally employed to maintain the level. That electricity bill you nearly burst a blood vessel over was probably computed during a heatwave, when the cores switched at the blink of a programmer's eyelid. At lower temperatures, ferrite cores require a larger magnetising force to switch, i.e., the H axis of the loop is larger. With higher temperatures, the H axis narrows and the B length increases, so the core is switched by smaller currents.

Output noise is one of the chief hazards in coincident-current systems, much of it caused by the currents in the address windings. Although these are at half-select current and cannot switch the cores, small voltages are generated in the sense wire which is threaded through the same core; after all, this is basically an inductance and the small voltage depends on current and inductance—remember the Right-Hand (or was it the Left-Hand ?) Rule. Skating swiftly past that hole in the ice, we can safely say that the noise voltages in the wires going one way are additive. So, to overcome them, the output wire is threaded through half the cores in one direction, and through the other half in the opposite direction.

Noise voltages cancel out—in theory. In practice, of course, just as we find when hooking up our tape recording equipment for a special recital, there are some quite unexpected snags. Electromagnetic coupling can be one of these, so it is necessary to try and make currents in adjacent wires throughout the whole system flow in opposite directions, unwanted magnetic fields cancelling out as much as possible, and coupling being reduced by the **A** and **a** wires (address wires) threading cores at right angles. Hence the particular way of wiring the matrix as shown in **fig. 2.**

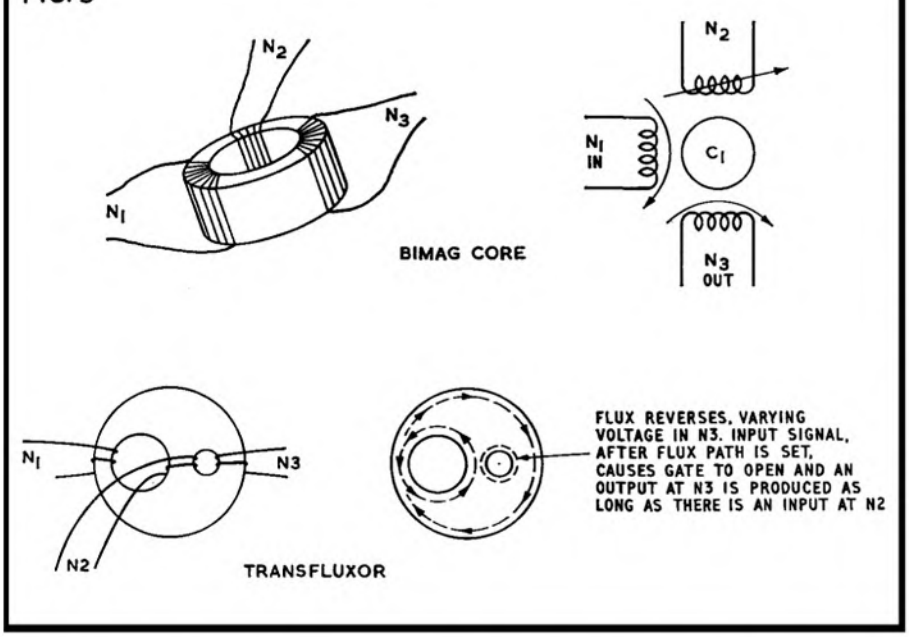
### OTHER TYPES

Two other types of magnetic core need a mention at this point. These are the bimag core and the transfluxor, or multi-aperture device (MAD). These are still characterised by the almost square hysteresis loop, but are used for switching, often in place of semiconductors in a quite different type of conformation. The bimag core, for example, may be used to construct a register called a magnetic shift register, which is a kind of temporary store from which information can be 'moved along' at predetermined intervals. The transfer pulses are applied through loops, which are windings on a toroid made of thin molybdenum *Permalloy* ribbon first wound on a ceramic former. After winding on its ceramic bobbin, the metallic tape is spot-welded, the core annealed, inserted in a plastic sleeve and fixed to a base. It is practically indestructible.

The multi-aperture device is a ferrite disc with (as its name implies) two or more holes in it. A two-hole device might have three windings in the formation shown in **fig. 5.** The holes in the disc are unequal in diameter and there are several interacting fluxes. A large current through the control winding serves to block the transfluxor by saturating it and a large current in reverse direction will be needed to unblock it. Then, an input pulse in the In winding causes a varying voltage in the Out winding, the principle being simply that of an a-c gate. Many of the logical functions of computers can be carried out with transfluxors and with logicors, which have more than two apertures.

It is easy, when studying these ferrite loops, cores, switches, registers, etc, of the magnetic system, to become too deeply involved in detail. The fascination of fundamental magnetism for some of our physicists is one of the reasons we have such very efficient tape recording devices today. In the computer proper, which has occupied our thoughts for the past couple of articles, magnetic tape finds its use more as an external storage device than a basic memory store. Information is recorded in blocks of data, in relatively vast quantity, and some of the sensing and addressing mechanisms make a tape recorder engineer green with envy. But more of that later.

FIG. 5



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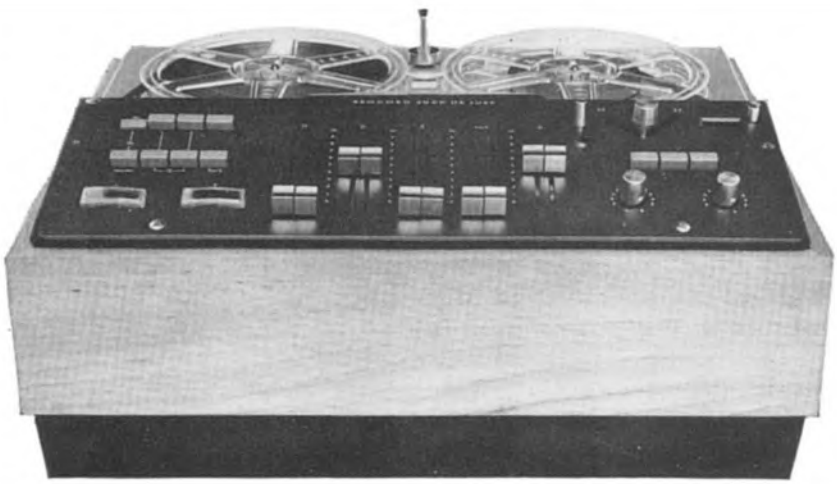

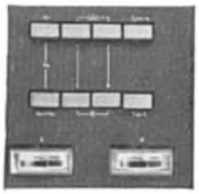


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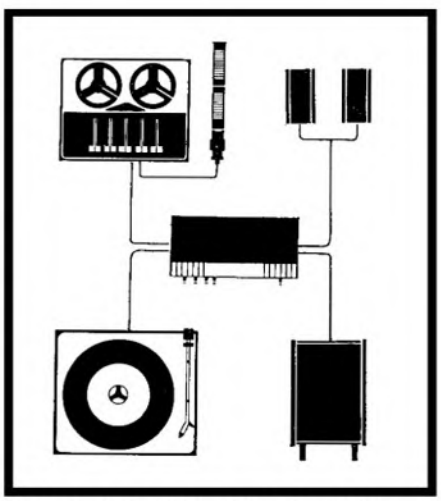

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# PERSONAL BIAS

## LISTEN TO THE LESSONS—A GLANCE AT RADIO BALLADS BY JOHN ASHCROFT

THE tragedy is that it took the loss of two lives in a railway disaster to give radio a new means of expression. On February 9th, 1957 as a freight train topped a Derbyshire hill, the engine's brake steam-pipe split. After a fruitless attempt to close the regulator, poking the firebox implements through a cab-full of scalding steam, the driver told his fireman to jump clear and try to lock down some wagon brakes while he stayed aboard and tried to close the regulator or at least warn the next signalman. Beyond control, the 2-8-0 locomotive hauling its heavy train plunged over the hill, down the long gradient, and smashed into the rear of another train at Chapel-en-le-Frith, killing both the runaway's driver and the guard of the other train. The driver was John Axon; he was posthumously awarded the George Cross, and his life and death inspired the first of the BBC Radio Ballads.

Perhaps with Casey Jones legends in mind, the BBC commissioned Charles Parker and Ewan MacColl to produce a documentary-cum-folksong tribute. They visited Stockport and the Edgeley Motive Power Depot, collecting sounds and voices on a portable recorder, chatting to John Axon's widow and workmates. The idea was that the actuality speech would suggest authentic phrases and atmosphere for an eventual script. But Parker and MacColl realised they'd blundered into a gold-mine, and thoughts of actors and actresses vanished. With all due respect to drama-schools, can you imagine one of their products saying: "The old railwaymen, it was a tradition; it went through—railways went through the back o' your spine like Blackpool went through rock!" and sounding as matter-of-fact as the railwayman who rapped out the words.

The remarkable pungency of the actuality speech convinced Parker and MacColl (soon joined by Peggy Seeger) that it must be used, complementing the composed songs in folk-idiom—even though patient editing was necessary to extricate some quotes from background blasts of steam.

### WITHOUT NARRATION

Leaving aside the opening and closing announcements, *The Ballad of John Axon* ran for an hour without orthodox studio narration. The narrative links were the verses of one song, threading its way through the programme; everything else was conveyed by songs, sound-effects, and actuality voices. But, slowly, as new ideas suggested themselves, the musical and actuality components lost their divisions and began to blend in a marvellous manner, and most earlier concepts of the programme went with the wind.

Sounds and actuality-speech excerpts were fed into the studio and treated by the musicians as fellow-performers. Charles Parker was apprehensive at first—he wondered if musicians of the calibre of Bruce Turner and Alf Edwards would be insulted when asked to accompany such snippets; but the musicians responded wonderfully to the unusual challenge.

The techniques were improved and evolved in further Radio Ballads devoted to coalmining (*The Big Hewer*), the herring-fleets (*Singing the fishing*), the M1 motorway (*Song of a road*), boxing (*The Fight Game*), gypsies (*The Travelling People*), and others, with varying success. *Argo* have already issued two of them as 12in. LP's in association with BBC Radio Enterprises—and more will follow. This will make these programmes accessible to those who missed the broadcasts; and, quite apart from their entertainment value, the Radio Ballads are object lessons in the flexibility of tape, imaginative editing, and the manipulation of sounds and voices.

The simple life and the dignity of the working man have inspired a great festering heap of starry-eyed twaddle shovelled forth by people ranging from political idealists to singers who'd die rather than dirty their hands or live in a house without plumbing. Certainly the folksong revival abounds with coy rubbish where sweetly-harmonised gutless crooning and slick accompaniments inadequately disguise the lack of all conviction, experience and musical or social maturity. *But*: give a capable singer a good meaty song with a simple but powerful accompaniment, and the results are no longer moon-eyed nonsense.

### VINTAGE PROJECTION

Anyone who has been rocked on his heels by Ewan MacCool's projection of vintage ballads and sea-shanties will not be too surprised by the often ferocious impact of the songs in these programmes, while the higher and gentler but equally authoritative voice of A. L. Lloyd provides a telling contrast.

Charles Parker once commented on the difficulties encountered in composing folk-style songs without collapsing into archaic yo-heave-ho sentimentality. Not every Radio Ballad song succeeds—but the majority do. Without departing too far from tradition, they are unmistakably twentieth century, generally devoid of rose-tinted outlook, often brutally lumpy with trade idiom, and seldom get stuck in the potholes of pretentiousness or pastiche.

(Personal taste, perhaps; but the description of the about-to-burst pipe in *John Axon* strikes me as pretentious melodrama; and the fast song describing the runaway, with its mannered repetition of "poor boys" and the last line of each verse, while startling and exciting on first hearing, begins to suggest a 'send up' of what Lonnie Donegan was singing at that time—the so-called 'skiffle' groups were wringing themselves dry in 1957.)

And take trade-sayings, workshop jokes, and occupational grumbles.

"Hey, lad—will you fetch me a bucket of red oil for a red tail-lamp?—Where've you been for that oil—Arabia?" I boggled briefly when Ewan MacColl once described such sayings as industrial folklore; but I'll grant him the point. They strike a chord, set a scene, they convince; fed into the programme with impeccable timing, they strike sparks. And the use of location recordings, with inflexions seldom recreated in a studio, gives them enormous punch.

The only actuality speech that jarred on me in *John Axon* came when driver Jack Pickford described the dawn seen from his footplate. On the first broadcast, this struck me as 'phoney.' Significantly, an excellent booklet enclosed with the LP reveals that this description was recorded several times "and, if anything, the quality of the speech was improved in the process." I beg to differ: the result is too good to be true, and plausibility slumps.

### WORTH STUDYING

But this booklet is worth studying: Charles Parker brilliantly sums up the difficulties in gathering useful actuality speech, in a passage that should be nailed on a recordist's bedroom wall where *Home sweet Home* once hung:

"The recordist is engaged on several levels; on the purely technical level of controlling his machine, on the level of the acoustic environment of his subject—alert for noisy traffic or jets or other interference, and with all this he must evince the passionate engagement of the good listener while yet directing the conversation to those channels most likely to be fruitful. Above all, he must communicate a belief in the capacity of the person he is with to speak well and tellingly of his experience of the subject at issue, and this usually in the teeth of all the pre-conditioning that our society engages in as if to convince ordinary people that they cannot express themselves adequately!" That last sentence really hits home!

The actuality speech excerpts selected for the Radio Ballads ring true, and are often earthy and poetic in the same breath. *Singing the Fishing* has hardly begun before you hear a veteran say: "If you fish for the herrin' they rule your life; they swim at night—you've got to be out there at night waitin' for 'em to swim. Course, it's a wonder too, y' see . . . pick one o' these little fish up, and it's vibrant wi' life—*Vvvvrrrr*!—like that. The numbers! You realise that it's only one of millions and millions and millions. When the little people swim up properly, they really do it. When you're doing well and catchin' fish, they talk to 'em all the time: 'Come on, spin up, my darlin's, come on! and they—you absolutely *cajole* 'em into the nets. And wherever the herrin' are, the fishermen'll go after 'em. You might be work-

(*continued on page 543*)

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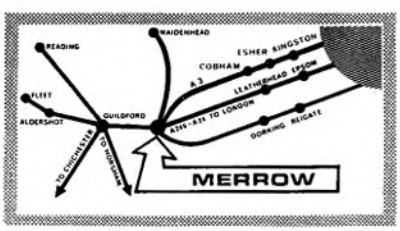


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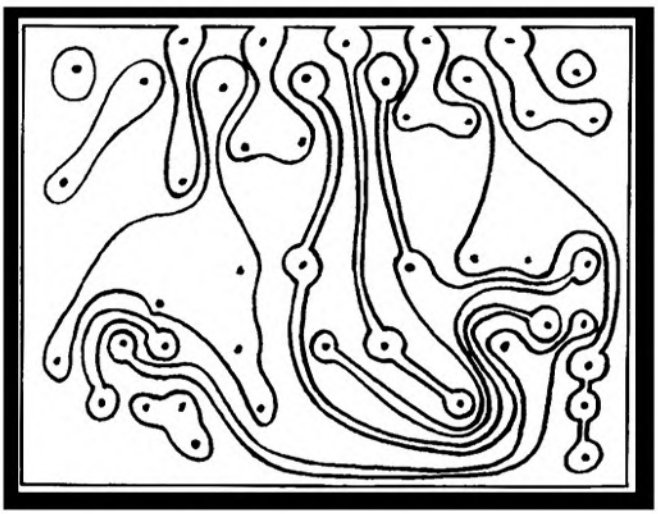

# ELEMENTS OF TAPE RECORDER CIRCUITS

PART 7 EQUALISATION

BY G. T. ROGERS

THE factors involved in equalisation have been discussed on several occasions in this magazine, so most of us will be familiar with the basic 6dB-per-octave response curve of a playback head, which is shown by the solid line in **fig. 1.** The straight part of this curve shows that the voltage induced in the playback head is directly proportional to the frequency ; as the frequency doubles so does the output voltage. A doubling in frequency corresponds to one octave and a doubling of voltage is a 6dB change, hence the 6dB per octave characteristic of the curve.

Beyond a certain frequency, known as the turnover frequency, this increase ceases and then falls off as shown ; one of the reasons for this is loss due to the finite gap in the replay head.

The response from a playback head is therefore far from being flat, and if the output voltage is directly amplified by a conventional amplifier, a very 'tinny' quality would result. To avoid this, the amplifier in a tape recorder must incorporate some form of compensation, or an equalisation circuit as it is called. Clearly this must have the effect of combating the rising output up to the turnover frequency and causing the response of the amplifier to flatten out or even rise beyond this frequency. The equalised response must therefore be a mirror image to that from the replay head, as shown by the dotted curve in **fig. 1.**

Compensation of low frequency losses is often applied either in the playback head first amplifier stage or in the coupling between this amplifier and the head itself. Treble lift, on the other hand, is usually provided in the record amplifier, although there are considerable variations in this.

It is, however, desirable for the tape amplifier designer to conform to one or more of the standard *replay* responses so that tapes recorded on one machine can be replayed on another. At present there are three sets of replay characteristics, DIN, CCIR and NAB (NARTB), and these all follow the mirror image of the 6dB/octave replay head response at the lower frequencies, apart from some deviation in the extreme bass. As we shall see later, the difference between these standards can be defined by the upper turnover frequency of the equalisation curve which is determined by the resistance and capacitance of the equaliser circuit. Another way of describing the equalisation curve is in terms of microseconds (millionths of a second), a time-constant which is obtained by multiplying the value of C in microfarads by R in ohms.

Basically there are two sorts of equalisation. In one case the equalised circuit is in the nature of a high- or low-pass filter where the desired frequencies are allowed to go unattenuated from one amplifier stage to the next, whereas the undesirable ones are blocked or shunted to earth. Another way of applying equalisation is by frequency-selective negative feedback. The principle of this is simple. If an attenuated *output* of an amplifier stage is fed back to the input grid at opposite phase, some cancellation of the signal occurs. In playback equalisation, the feedback is so controlled that it is a minimum at the bass end of the spectrum and gradually increases towards the turnover frequency. In this way the gain of the replay head amplifier is caused to decrease with increase in frequency and so gives the desired treble attenuation.

Let us consider first some basic filter circuits. **Fig. 2a** shows a simple low-pass filter where the high frequencies are attenuated because the impedance of the capacitor becomes smaller as the frequency arises. Since the resistor and the capacitor are across the input voltage they form a potential divider, and as the frequency rises the output across the capacitor becomes a smaller portion of the input voltage. This, of course, is applying the basic theory which we talked about in Parts 1 and 2. The lower turnover frequency, where the circuit's output begins to drop with increasing frequency, occurs when the resistance and reactance of the capacitor are equal. Above this frequency the output falls by the 6dB-per-octave characteristic, shown as a solid line in **fig. 2c,** but this time it is due to inverse proportionality between the frequency and reactance of the capacitor.

If the output is taken across the resistor instead of the capacitor, the circuit would have the opposite effect, that is, it would have the characteristic of a high-pass filter. In this case low frequencies would be attenuated by the reactance of the capacitor whereas high frequencies would pass unimpeded.

Unfortunately, these simple circuits have one disadvantage : they have a continuing decline at either the treble or bass end of the spectrum and this is often undesirable in practical circuits. However, the circuit illustrated by **fig. 2b** gives a more satisfactory response where the output levels off at both the upper and lower frequencies. The solid line in the accompanying response curve shows the effect of $R_1$ and C, thus as the frequency rises the decrease in reactance of the capacitor causes the output to drop. At very high frequencies the reactance of C is negligible compared with $R_2$ and the equivalent circuit is a constant voltage divider comprising $R_1$ and $R_1$. This imposes a lower limit to the drop in frequency response as shown by the dotted part of the curve in **fig. 2c.** This is known as the upper turnover frequency. For practical purposes the overall effect of this circuit is bass boost, although in specific terms it is really treble attenuation.

As we have seen, the playback head itself, being an inductive device, has an output which increases 6dB-per-octave as the frequency *rises.* Clearly the response of the equaliser must be opposite to this, in fact it has to rise 6dB-per-octave as the frequency *decreases.* The simple bass boost circuit, **fig. 2b,** has such a characteristic and is suitable for use in a playback equalising circuit like that shown in **fig. 3.**

Resistor $R_1$, of **fig. 2b,** is made up in this circuit from the parallel arrangement of the load resistor $R_l$, the AC anode resistance of the pentode and theg rid resistance $R_g$. This parallel resistance together with the capacitor C determines the lower turnover frequency as described above. The limit to the high frequency response, that is, the upper turnover frequency, is determined by the values of C and $R_2$ and is the frequency at which the reactance of C is numerically equal to the value of $R_2$. In NAB playback equalisation (90μS) the upper turnover frequency is 1760 Hz, but for CCIR characteristics (140μS) it is 1120Hz at a tape speed of 3¾ i/s.

In some cases triodes are preferred to pentodes as input valves in such circuits, since they generally produce less hum and noise.

*(continued on page 537)*

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| 7" | 2400' | 21/9 | 37/6 |

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Also, there are many practical variations of these circuits in use—but discussion of these is beyond the scope of this article.

Returning to our discussion on basic circuits, let us now consider another way in which playback bass boost can be achieved, notably by frequency selective negative feedback. We have already mentioned the principle of this, but now it is worth pointing out the two basic ways in which the effective input voltage can be reduced. Firstly, this can be done by applying to the *grid* a feedback voltage at opposite phase to the audio input. Secondly, the feedback voltage with the same polarity can be applied to the cathode of an amplifier stage. In the latter case the feedback voltage will cause the cathode to vary in the same direction as the grid and hence the voltage between the grid and cathode is reduced, thereby cutting down the effective input.

The amplifier stage shown in **fig. 4** has negative feedback applied to the grid. Here the audio signal is amplified and appears at the anode in *opposite phase*. The overall negative feedback is governed by the resistor R in the loop circuit, the smaller its value the greater the feedback and the smaller the gain of the amplifier stage.

However, the capacitor modifies this since its reactance increases with decreasing signal frequency. At the low end of the spectrum, then, the reactance is high and the feedback consequently reduced, thus increasing the gain of the amplifier. At very high frequencies, on the other hand, the reactance of the capacitor becomes very small and then the minimum gain of the amplifier is fixed by the resistor.

In anode to cathode feedback two amplifier stages are usually involved so that the polarity of the grid input to the first stage is the same as the polarity of the amplified voltage at the anode of the second stage where the feedback originates. The simple frequency discriminating R-C networks, like the ones described above, are used in the feedback loop so that the desired treble attenuation can be obtained.

Since gain of the amplifier does not vary purely with feedback, the response of a feedback equaliser in the region of the lower turnover frequency may be more gradual than a corresponding filter type. In practice this lack of precision at the lower turnover point impairs the bass boost properties of the equaliser, and it may be necessary to correct for this. One way is to lower the turnover frequency, although frequently it is possible to combined a filter type circuit with the feedback network so that the corresponding curves add up to a characteristic approaching either NAB or CCIR equalisation.

In practice feedback circuits are superior to the filter circuits for playback equalisation and there are two reasons for this. Firstly, any distortion generated in the amplifier stage is reduced, and secondly, when a filter circuit is used between two amplifier stages or between the head and head amplifier, the signal applied to the amplifier via the filter is always below its maximum and this causes trouble from the signal-to-noise ratio aspect. A description of why this should be so is given

(*continued on page 544*)

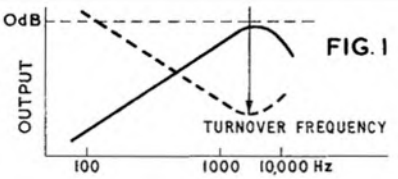



FIG. 1

FIG. 2

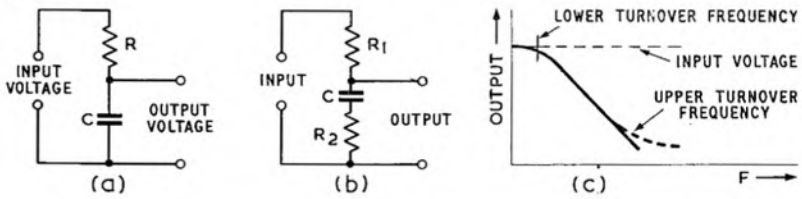



FIG. 3

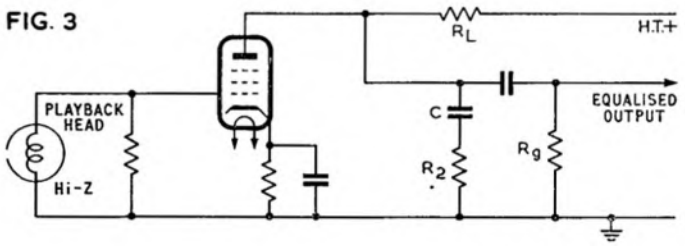



FIG. 4

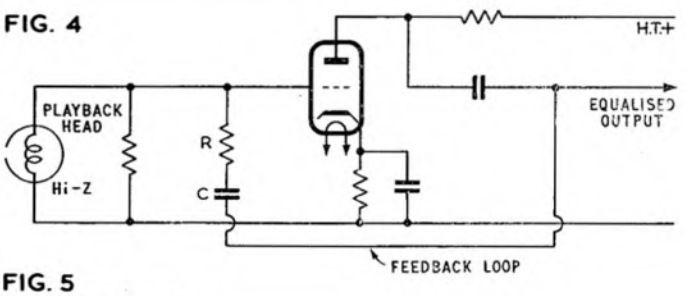



FIG. 5

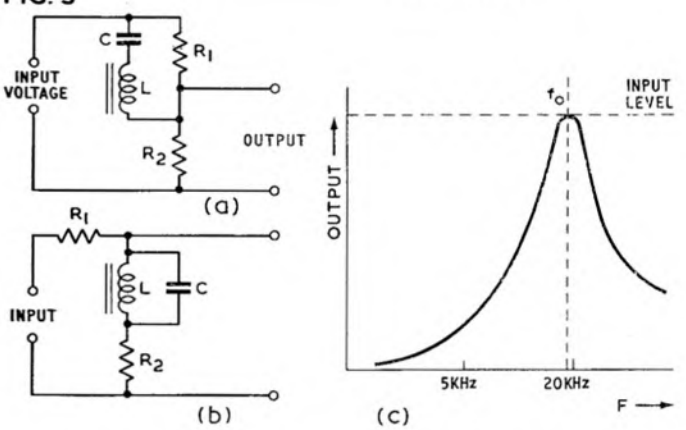
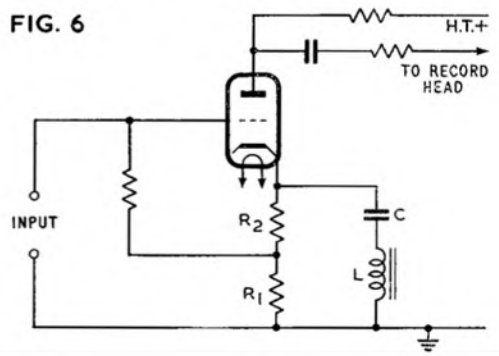
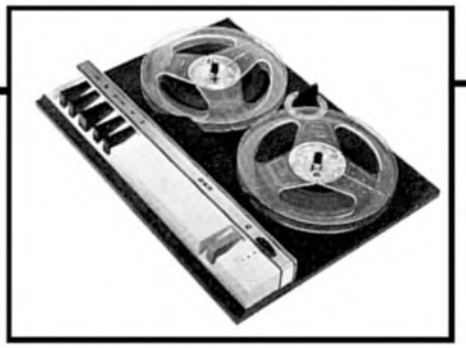



FIG. 6



# equipment reviews

## BSR TD.20 TAPE DECK



**MANUFACTURER'S SPECIFICATION.** **Tape Speeds:** 7½, 3¾ and 1⅞ i/s. **Wow and flutter:** 0.1%, 0.2% and 0.3% respectively. **Spool Capacity:** 5¾in. **Pause control:** Optional three-digit turns indicator. **Dimensions:** 12½ x 10 x 4½in. **Price:** £14 (¼-track), £15 (¼-track). **Manufacturer:** BSR Ltd., Monarch Works, Old Hill, Staffordshire.

THE *TD.20* is the third tape deck to be produced by *BSR*. The *TD.2* was the first and has been in production now for nearly eight years. The *Mk. 1* version was described in detail in the 5th issue of this magazine in June 1959. It was affectionately known in the trade as 'the coffee grinder' and was indeed a bit rough in many small ways. Over the years small modifications were made: idler wheel instead of belt, bigger motor stack for cooler and quieter running, heavier flywheel and improved bearings, well screened heads with finer gaps, more robust pressure pad mounts, etc., etc. Today it is recognised as one of the most reliable tape decks available to British manufacturers.

Four years ago the *TD.10* appeared with three speeds and space for 7 in. reels, but with the same basic design using a joystick for control of all tape movement and a spring loaded record key which was released when the joystick was moved to the off position.

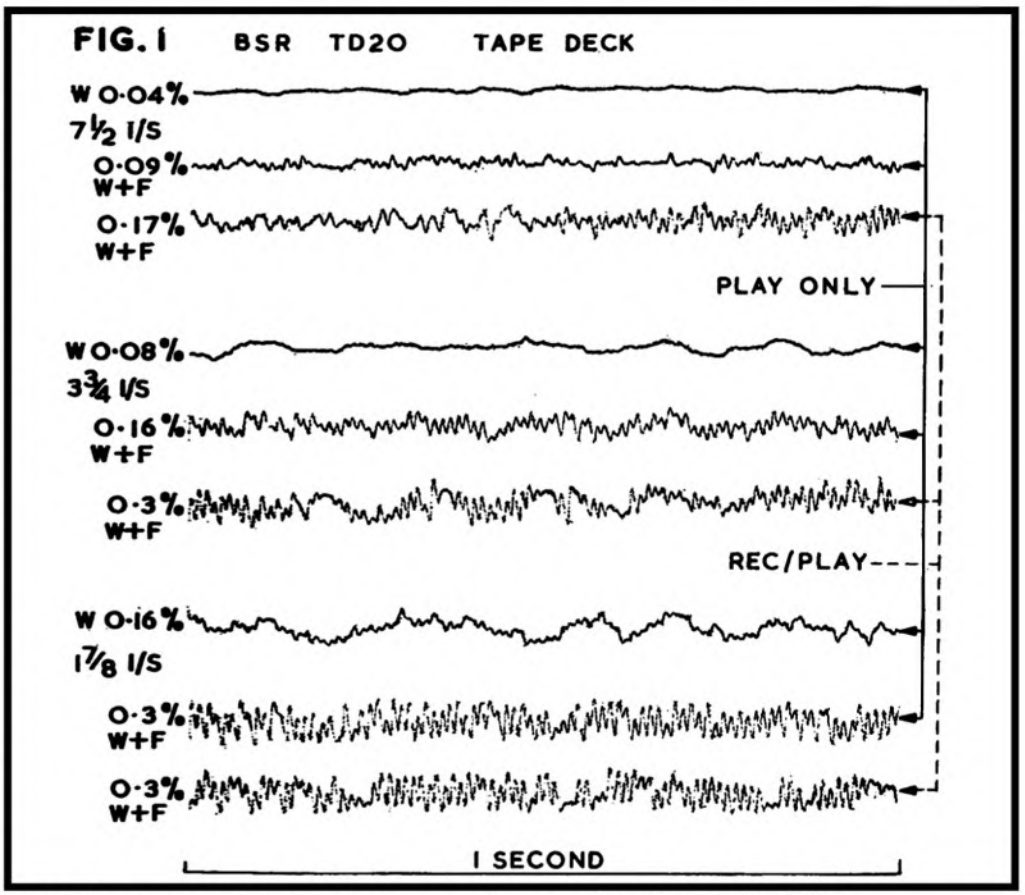
The new TD.20 uses press tabs instead of the familiar joystick and these are fitted to the left-hand side of the deck. Reading from left to right, the functions are: fast left-wind, fast right-wind, stop, play and pause. To the right of the heads is a recessed red record key which must be pressed down and locked into position by operating the play key to switch to record and which is released by pressing the stop key.

A three digit tape position indicator can be fitted as an optional extra to the right of the record key. Presumably it is driven from the adjacent take-up reel instead of the supply reel as in the other BSR decks. I should perhaps explain that the early review sample deck was not fitted with the counter or with the plastic top cover.

Mechanical running noise seemed to be reasonably low as far as could be judged on an open unmounted deck, but operation of the press tabs, which had a slightly 'gritty' feel, produced some rather alarming 'twanging' noises from undamped springs and ringing metal.

Tape movement seemed to be well controlled at all speeds and on braking from fast wind or rewind. Long term tape speeds were measured by strobe tape and constant frequency tapes and found to be within ±2% limits over a 5¾in. reel at all speeds.

To measure the short term speed variations or 'wobble', I have adopted a new technique which isolates the record and play wobble so that the 'finger print' of the deck motion is not obscured by cumulative adding and cancelling of cyclical speed variations which occur on both record *and* play. To do this I have recorded virtually wobble free tapes on the Revox 736HS which, when replayed at 7½, 3¾ and 1⅞i/s, produce a 3kHz tone for feeding the *WHM* fluttermeter with total RMS wow of less than 0.02%, and a combined wow and flutter, or wobble, content of less than 0.05%. Such a tape played on a review recorder or deck displays only *play* speed fluctuations and gives a much steadier RMS meter reading and more repeatable pen recording for analysing the causes of the short term speed variations.




The top trace of fig. 1 shows that the wow at 7½ i/s is only 0.04% with a just visible trace of wobble at approximately 12Hz due to capstan eccentricity. The middle trace shows the combined wow and flutter, with a bandwidth of 200Hz on the meter and 120Hz bandwidth on the pen recorder, on play only. The lower trace shows the usual cumulative wow and flutter when playing a recording made on the TD20 deck. The wide bandwidth RMS meter reading is 0.17% and CRO examination of the high frequency flutter showed that it contained frequencies well beyond the high frequency limit of the pen recorder.

The middle set of traces are for a tape speed of 3¾ i/s, giving RMS readings of 0.08%, 0.16% and 0.3% and showing evidence of a slight 6Hz capstan wobble together with increased very high frequency flutter.

The 1⅞ i/s traces show the capstan effect at

(*continued on page 541*)

# A Winner

The DP4 microphone is another winner—by performance alone it has achieved world wide acclaim. It is used regularly by P.A. engineers, broadcasting and television companies, film studios, etc., as well as by many professional and amateur tape recordists. Its winning qualities have been designed and produced by Grampian—specialists for over thirty years in the field of sound equipment. We shall be pleased to send you full technical details of the DP4 and other microphones, together with descriptions of various accessories.

Specially designed to use with the DP4, in order to cut down wind noise is the Windshield — as illustrated here.

There is also the "Grampian" Parabolic Reflector. Where it is not possible to place a microphone close to the source of sound such as when making recordings of bird songs, weddings, car and train noises etc. the Parabolic Reflector has been proved over and over again to be of enormous value.

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approximately 3Hz with even more high frequency flutter.

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The high frequency flutter is not due to any rotating part of the tape transport system, but is a friction effect between tape, guides, heads or pressure pads. All guides and tape bearing surfaces were thoroughly cleaned, and all samples of tape tried gave similar effects, so that some further attention must be given to the tape path if this high frequency flutter is to be reduced or eliminated.

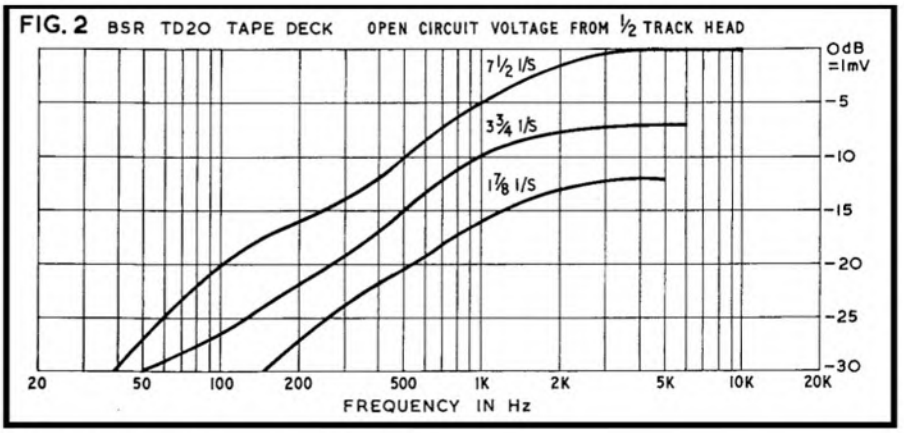
**Fig. 2** shows the open circuit voltages from a ½-track head when playing 70, 140 and 280μS test tapes at tape speeds of 7½, 3¾ and 1⅞ i/s. The curves are smooth and level in high frequency response, so that simple R/C equalisation in the playback amplifier will give a level response over the ranges shown.

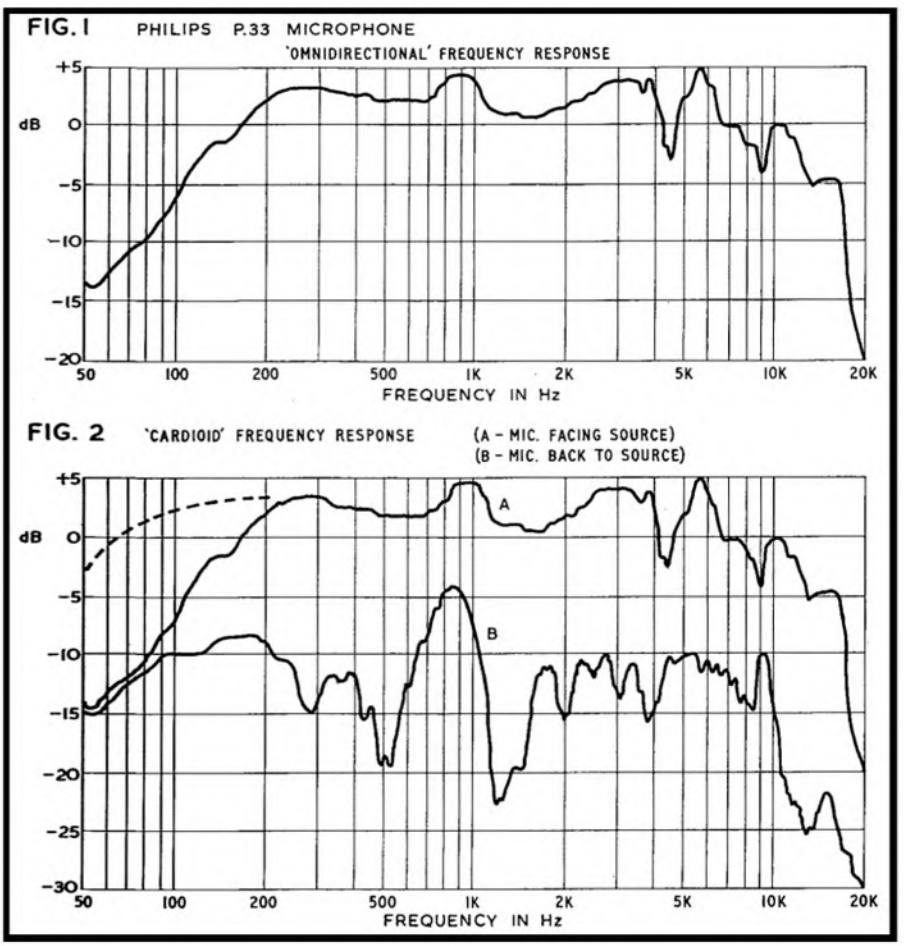
This is the usual pattern of an early sample of a newly designed deck and I have little doubt that these teething troubles will be quickly dealt with by the production team at BSR.

A few damping sleeves on critical springs and some smoothing of the stamped edges of certain levers will almost certainly take away the rough feel of the press tabs and at the same time reduce the operating noise.

The tape friction may be a simple matter of different plating on the guides or a softer felt on the pressure pads, or even a slight change in tape tension by altering the slight back tension of the supply reel turntable.

I look forward to meeting a number of these decks in future review recorders and being able to report detailed improvements as they come along. **A. Tutchings**

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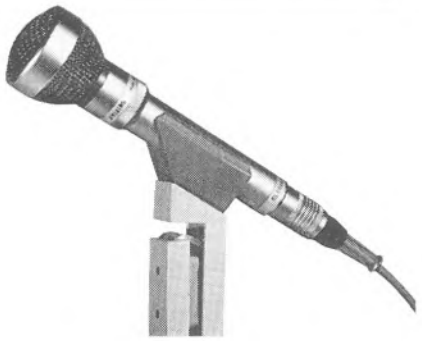
THIS microphone is a high quality multi-function unit. It consists basically of a moving coil transducer in which the cavity behind the diaphragm can be either (a) sealed, when it will perform as a normal pressure (omni-directional) type microphone with a spherical response, or (b) open to the air through a controlled acoustic resistance, when, because of the phase shift between the sound pressure on each side of the diaphragm, its polar response will be cardioid in shape.

The microphone consists of a stem approximately 4½ inches long by ¾ inches in diameter with a 'tulip' shaped top 1⅝ inches in diameter. The metal parts are finished in satin chrome and charcoal grey. At the junction between the head and the stalk is fitted a knurled ring controlling the acoustic network which can be adjusted to give either spherical or cardioid response. It weighs about 7 ounces and is very comfortable to hold. Termination is a standard DIN 3-pin socket and the 15 ft. of cable supplied with it is two-core screened low-noise cable. Nominal impedance is 500 ohms and, because both terminals are floating, the microphone can be used on balanced 500/600 ohm circuits. A plastic clip is also supplied with a brass insert to fit standard ⅜ inch, ½ inch and ⅝ inch Whitworth form screws, thus enabling it to

*(continued on page 546)*



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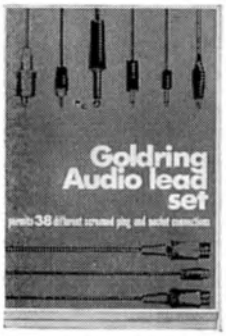


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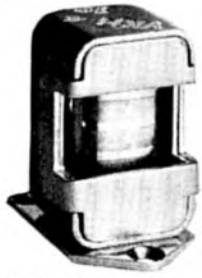

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ing two hundred miles from Aberdeen on the Norwegian deep water, or off Shields—if the herrin' are there, you have to go and get 'em."

Now read again that quote from Charles Parker. Much blood, sweat and tears must have gone into the Radio Ballads; but the rewards can be immense, however infrequently the microphone catches material like that.

As for doubts about inviting musicians to accompany location recordings . . . hear the melancholy eloquence of Bruce Turner's saxophone behind memories of "poor old times" when the depression hit the herring-fleets, and its follow-up to the song by the two Stewart girls—almost a continuation of their voices.

Another brilliant sequence features cross-reminiscences of storms at sea, underlined by Alf Edwards whose bass-concertina rumbles and growls into prominence at a crucial word and lifts you from your seat; and the tension is enhanced by progressively faster recordings of a fish-auctioneer's patter, a magnificently ironic counterpoint, backed by the urgent picking of Peggy Seeger's banjo. The mood created is almost agonising—and very educational!

### MAGIC MACHINE-ROOM

People talk of magic moments. One night I took a portable into a newspaper machine-room. At first the headlines and photos were recognisable as they passed smoothly through the presses; a few minutes later they were mere continuous blurs along the racing path of white. Somewhere between these extremes, the presses hit a catchy rhythm and an operator near the microphone began to whistle jauntily. At first I gritted my teeth ("Another recording ruined!") but when I replay the tape it gives me an enormous kick. There's a sudden and absolute identification, a harmony, between the man and the machinery, and it might almost be unconscious—I feel that the operator might be surprised to learn what he'd been doing.

It's difficult to convey my subjective reaction; but the Radio Ballads often touch the same nerve. That cheery whistling added to a fading train rhythm in 'John Axon,' and the rhythm section adding a heartbeat to the locomotive's lungs . . . it all suggests the extraordinary potential of blending actuality sounds and music and mechanical rhythms, a potential which has been exploited in film sound-tracks but seldom if ever by most amateur recordists.

A guitar and bass can lift a train recording into another dimension; and there's tremendous scope, surely, for just humming, singing wordlessly, or improvising on an instrument as simple as a tin whistle or mouth-organ behind actuality inserts. Offhand, the only startling use of any such technique by an amateur that I recall hearing came in the winning entry for the BBC 'Summer' contest in 1966, where a wordless vocal link was employed with ear-waggling effect. And between sections of a taped documentary a few simple guitar or other musical notes could make ideal links . . . but how often do amateurs use the idea? In this respect the Radio Ballads are object lessons.

They are also object-lessons in editing. One sequence in *Song of a Road* introduced a random collection of workmen's voices mentioning their home towns or countries; somehow, despite vast differences in acoustics and background noise, these were close edited into a place-names panorama that was brilliantly effective—and certainly more powerful than any 'in studio' narration that might have attempted to convey the remarkable diversity of origins of the men who built the Motorway.

The Radio Ballads have their faults; they can become pretentious, and can succeed only with certain strong types of material—one based on Adolescence struck me as very disappointing; a more promising one about gypsies and tinkers suffered when the preaching and propaganda got a little out of hand; and, being prejudiced, I'm sorry the team never tried the theme of getting a newspaper edition out against the clock, a subject which seems absolutely ideal for the Radio Ballad format and techniques.

### ANY ATTEMPT

Sometimes these techniques themselves are used to excess ("Technique run riot" was one programme planner's reaction to the first Radio Ballad); a friend was genuinely irritated by the alternation of actuality speech with lines of a song in *Singing the Fishing*. But any attempt to fuse traditional folksong modes, new lyrics, guitar and banjo rhythms, jazz instruments, actuality speech, and sound-effects, is so fraught with potential catastrophe that it's a miracle the programmes succeed as well as they do.

They're an education in the arts of editing, mixing, cross-fading, building and releasing tension, and choosing and using sounds to paint pictures. You might like them very much, you might violently dislike them. But you can surely learn from them . . . and I wish every amateur recordist would sit down and really listen to them.

Argo RG 474—*The Ballad of John Axon*
RG 502—*Singing the Fishing.*

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*"Nowadays, with so many programmes on tape, raw tape stock is a costly item in the BBC's budget. Consequently, increasing use is made of lower tape speeds and/or ½-track working which still permit signal-to-noise ratios and audio bandwidths equalling many programme circuits. (In the external services, much use is now made of 3¾ i/s.)"*

*'FM Diary,' November Hi-Fi News*

in Gordon J. King's article 'Inductance and Equalisation' *Tape Recorder* July 1965.

In transistorised equipment, frequency-selective feedback like that described for the valve circuit can be employed. However, if the amplifier is designed to have low input impedance, as normally occurs when local negative feedback is not applied, the inductance of the playback head itself can be arranged to assist with the equalisation. From the equation $X_1 = \pi\ 2fl$, which we introduced earlier in the series, it can be seen that the inductive reactance $X_1$ rises with increased frequency $f$, which means that the current in the circuit is greatest at the lowest frequency and falls as the frequency rises.

So far, then, we have exposed some of the fundamentals of playback equalisation which is required to give considerable bass boost to combat the 6dB-per-octave characteristic of the playback head. In addition to this, certain high frequency losses (particularly self demagnetisation at high frequencies) have to be compensated for, and this can be done conveniently in the record amplifier.

If the equalised response is to be reasonably flat out to, say, 15kHz, the required treble boost curve must have a slope greater than 6dB-per-octave, and one way of doing this is by using two or more two-element filters. However, this is not a very good way of tackling the problem since the loss of gain—the insertion loss—will generally be excessive and this means an extra stage of amplification which puts up the price of the recorder. A more elegant way to obtain a steeper curve is to use an R-C-L network.

Two representative R-C-L circuits together with a typical response curve are shown in **fig. 5** and provide the well-known sharply rising characteristic of a resonant circuit.

In the first circuit, **fig. 5a**, the resistors form a potential divider and if $R_2$ is made considerably smaller than $R_1$, the output over most of the audio range will be less than the input voltage, the maximum attenuation being called the insertion loss. At resonance, however, since C and L are in series, the impedance offered by these components becomes very small. The resistor $R_1$ is then bypassed and $R_2$ becomes the larger leg of the potential divider and the output rises rapidly. The resonant frequency itself, which might be 20kHz is related to the values of L and C, though the sharpness of the resonant peak depends on the values of L and C compared to $R_1$.

### SECOND CIRCUIT

The second circuit, **fig. 5b**, features an inductor and capacitor in parallel and we shall remember from Part 3 that this arrangement offers maximum impedance at the resonant frequency, the impedance falling off on either side of this frequency. Again we have a potential divider and over most of the audible range $R_1$ forms the larger leg. The output across L, C and $R_2$ will therefore be reduced over most of the spectrum. As the resonant frequency is approached however, the impedance of the L-C parallel circuit will rise until it is a maximum at the resonant frequency. The inductor capacitor and $R_2$

will then form the larger leg of the potential divider and the output rises.

The resonant frequency of **fig. 5b** depends on the values of L and C, whereas the maximum gain (the low frequency shelf) can be varied by altering the value of $R_2$ with respect to $R_1$. Further, the point at which the treble boost begins (turnover frequency) can be controlled by varying L with respect to $R_2$, although C will have to be re-adjusted to give maximum response at the desired resonant frequency. In this way the slope of the treble boost curve can be varied.

R-C-L treble boost circuits are therefore ideally suited for record equalisation. Firstly, they have the desired sharply rising characteristic of a tuned circuit and, secondly, they are flexible. This is important to the designer since by the use of variable components the treble boost can be tailored at the design stage to coincide with any variation required to meet the associated amplifier circuit, optimum bias and the recommended tape.

The precise way in which an R-C-L treble boost circuit is used in a record amplifier of course depends on its design, which is in turn related to the quality and price of the recorder. A circuit similar to that in **fig. 5a** might be used between two amplifier stages as a filter type equaliser, but there are advantages in using a negative *current* feedback circuit such as **fig. 6.** This type of circuit, besides giving the necessary response, serves to reduce distortion since any distortion frequencies not originally present in the signal are applied to the input signal at opposite phase and some cancellation of these components therefore occurs.

Unlike voltage feedback, current feedback can be generated by using a large cathode resistor $R_1$. To understand the working of this circuit let us assume that the signal applied to the grid is positive so that there is an increased current flow in the valve, and hence through the large cathode resistor $R_1$. This causes a larger voltage to develop across this resistor and electrons are drawn from ground to cathode. The cathode thus becomes positive with respect to ground. The effect of this is that the polarity of the cathode varies in the same direction as the signal at the grid and the effective input is reduced. The larger the cathode, or feedback resistor as it is called, the greater the feedback generated and the lower the overall gain.

To achieve treble boost equalisation it is only necessary to by-pass the feedback resistor by an inductor and capacitor in series as shown in **fig. 6.** At low frequencies the amount of feedback is determined by the combined impedance of R, C and L, but as the frequency rises the series impedance of L and C becomes low and these components act as a bypass to $R_1$. The feedback is therefore decreased and the gain increased. Maximum gain. of course, occurs at the resonant frequency of L and C when the impedance is a minimum.

The resistance $R_2$ between the cathode and feedback resistor maintains the grid at the correct negative bias voltage relative to the cathode, and, as we have seen in an earlier part of this series, this is necessary for linear operation of the valve. Next month we shall move on and consider the recording level indicator.

be fitted to the majority of available microphone stands. Because the clip is "springy" the microphone can easily be removed from the stand for use by soloists, etc. Its prime use is as a general purpose microphone for small orchestras with soloists—i.e., used as omni-directional for the ensemble and cardioid for the soloist.

Sensitivity is 200 μV per μB and signal-to-noise ratio is at least 50dB. The free field response of the microphone in the omni-directional position is shown in **fig. 1,** from which it will be seen that it is flat ±2dB from 120Hz to 12kHz, with a roll off below 120Hz of approximately 6dB per octave. In the cardioid position the response is substantially identical although when used for close speaking the bass response will be augmented and will be approximately flat, as shown by the dotted line. The front to back response is better than 10dB over most of the range with the exception of a 'bump' occurring at 800Hz, but this discontinuity does not apparently colour either speech or music. In use, the microphone is completely hum free, and is insensitive to mechanical shock. When used in the cardioid position at one foot speaking distance, the speech is crisp, well 'forward', with a slight tendency for the sibilants to be accentuated. The bass response is adequate without being 'chesty'. With a small ensemble (omni-directional position) a slight amount of bass lift is necessary to counteract the brilliance of the brass and snare drums. With approximately 8dB of lift at 100Hz the double bass is extremely well reproduced.

Conclusions : this is a versatile, excellently produced and styled professional microphone in the lower price bracket (£24). It represents excellent value for money and can be recommended for small groups who require a universal microphone. It will require a matching transformer or mixer unit if used with domestic tape recorders, and under these conditions the limitation of performance will probably be in the tape recorder itself or the loudspeaker system.

**Stanley Kelly**



of the treble control are frequently found in this kind of feedback tone control and are not noticeable in use.

The 10kHz filter cuts the output at that frequency by 3dB, at 20kHz it is down by 10dB; the slight rise in output an octave below is not objectionable and is easily corrected with the tone control. The 6kHz filter cuts the output by 3dB at 6kHz, by 8dB at 10kHz and 14dB at 20kHz, with only the slightest rise below the turnover frequency. The filters are adequate in use for most material, in conjunction with the treble control.

The temperature stability of the circuits appears good, although there is not normally much heating on normal programme material. At the end of an evening's listening, the casing is just perceptibly warm. As regards output stability, the amplifiers should not be loaded with purely or largely capacitive loads such as electrostatic loudspeakers, as the phase shift due to the relatively low cut-off frequencies of the power transistors is likely to cause HF oscillation ; stability would probably be improved by the use of the more recent 2N2147 drift-field type output transistors, although I have not tried this, and they are rather expensive.

The amplifier went on its first recording trip some 15 minutes after completion, and indeed was used 'naked' for three nights very successfully on a recording of the Bath *Bach Choir*. It proved a most useful monitor, and the use of the floating outputs has simplified connections in subsequent recordings. In conjunction with the turntable, etc., with which the amplifier is housed in a piece of my father's cabinetwork, and with the Maxims, it has formed a very compact and useful piece of equipment for listening in a modest sized room where space is at a premium.

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